facility; however, the analysis did support the use of a radar system on deepwater facilities if the annual costs of the system were less than or equal to $124,500.

The OCS-related vessels could collide with marine mammals, turtles, and other marine animals during transit. To limit or prevent such collisions, NOAA Fisheries provides all boat operators with "Whalewatching Guidelines," which is derived from the Marine Mammal Protection Act. These guidelines suggest safe navigational practices based on speed and distance limitations when encountering marine mammals. The frequency of vessel collisions with marine mammals, turtles, or other marine animals probably varies as a function of spatial and temporal distribution patterns of the living resources, the pathways of maritime traffic (coastal traffic is more predictable than offshore traffic), and as a function of vessel speed, the number of vessel trips, and the navigational visibility.

4.3.4. Chemical and Drilling Fluid Spills

Various chemicals are applied to the well or to the production process. Some of the chemicals used exhibit hazardous characteristics, such as corrosivity or toxicity to aquatic organisms. The manufacture, storage, transport, handling, and disposal of these chemicals are regulated by several agencies including USEPA, OSHA, and USCG. Discharges from offshore facilities are limited by the USEPA NPDES permit limits. Other releases of these chemicals are not allowed; however, an accidental spill could occur during offshore transport or storage. A recent study of chemical spills examined the types and volumes of chemicals used in OCS activities. The study determined that only two chemicals could potentially impact the marine environment—zinc bromide and ammonium chloride (Boehm et al., 2001). Both of these chemicals are used for well treatment or completion and therefore are not in continuous use; thus, the risk of a spill for these chemicals is very small. Most other chemicals are either nontoxic or used in small quantities.

Zinc bromide is of particular concern because of the toxic nature of zinc. The study modeled a spill of 45,000 gallons of a 54-percent aqueous solution, which would result in an increase in zinc concentrations to potentially toxic levels. Direct information on the toxicity of zinc to marine organisms is not available; however, the toxicity of zinc to a freshwater crustacean (*Ceriodaphnia dubia*) indicated that exposure to 500 ppb of zinc results in measurable effects. One factor not considered in the model is the rapid precipitation of zinc in marine waters, which would minimize the potential for impact.

Ammonium chloride was modeled using potassium chloride as a surrogate. The model looked at a spill of 4,717 kg of potassium chloride powder. The distribution of potassium would overestimate the distribution of ammonia released during a spill. The model indicated that close to the release point, ammonia concentrations could exceed toxic levels for time scales of hours to days. Additional information on the degradation of ammonia in seawater would be needed for a more complete evaluation.

Accidental riser disconnects could result in the release of large quantities of drilling fluids and are of particular concern when SBF are in use. The use of SBF occurs primarily in deepwater where large volumes can be released. Three recent (2000-2001) riser disconnects occurred in the GOM OCS. Each release occurred as a result of unplanned riser disconnect near the seafloor. The contents of the riser was discharged within an hour of the disconnect. In all cases, approximately 600-800 bbl of SBF were discharged at the seafloor. The fate and effects of such a large release of SBF have never been studied. Localized anoxic conditions at the seafloor would be expected as the SBF is biologically degraded.

4.4. ENVIRONMENTAL AND SOCIOECONOMIC IMPACTS – ACCIDENTAL EVENTS

4.4.1. Impacts on Air Quality

Accidents related to a proposed action, such as oil spills and blowouts, can release hydrocarbons or chemicals, which would cause the emission of air pollutants. Some of these pollutants are precursors to ozone. Typical emissions from OCS accidents consist of hydrocarbons; only fires produce a broad array of pollutants, including all NAAQS-regulated primary pollutants. The criteria pollutants considered here are NO_2, CO, SO_x, VOC's, and PM_{10}.

Once pollutants are released into the atmosphere, atmospheric transport and dispersion processes begin circulating the emissions. Transport processes are carried out by the prevailing net wind circulation. Dispersion depends on emission height, atmospheric stability, mixing height, exhaust gas temperature and velocity, and wind speed. For emissions inside the atmospheric boundary layer, the vertical heat flux, which includes effects from wind speed and atmospheric stability (via air-sea temperature differences), is a better indicator of turbulence available for dispersion (Lyons and Scott, 1990). Heat flux calculations in the EPA (USDOI, MMS, 1988) indicate a year-round upward flux, being highest during winter and lowest in summer.

The mixing height is very important because it determines the space available for spreading the pollutants. The mixing height is the height, above the surface, of the top of the layer through which vigorous vertical mixing occurs. Vertical mixing is most vigorous during unstable conditions. Vertical motion is suppressed during stable conditions and, hence, the mixing height for such times is undefined; these stagnant conditions generally result in the worst periods of air quality. The mixing height tends to be higher in the afternoon, more so over land than over water. Further, the mixing height tends to be lower in winter, with daily changes smaller than in summer.

Oil exposed to the atmosphere has the potential to contribute to air pollutants through evaporation of the volatile components of the oil. The number and volume of spills estimated to occur as a result of a proposed action are presented in **Chapter 4.3.1.2.**, Risk Charaterization for Proposed Action Spills. The most likely source of an oil spill ≥1,000 bbl as a result of a proposed action would be from a pipeline break. **Figure 4-10** shows the four locations analyzed—two EPA locations in the DeSoto Canyon Area and two CPA locations in the Mississippi Canyon and Viosca Knoll Areas. For spills originating within the proposed lease sale area, **Tables 4-35 and 4-36** summarize the calculations for the two scenarios representing two possible oil types and two locations within the EPA. An oil spill (assumed size of 4,600 bbl of Neptune Composite Oil spilled over 12 hours) from a pipeline break during the summer was modeled for a period of 3 days (**Table 4-35**). At the end of 3 days, all of the spilled oil was lost, partly due to evaporation. An oil spill (assumed size of 4,600 bbl of Heavy Arabian Crude over 12 hours) from a pipeline break during the winter was modeled for a period of 30 days (**Table 4-36**). At the end of 10 days, 19 percent of the EPA slick remained on the water's surface; the loss was partly due to evaporation. The contribution of oil-spill emissions to the total VOC emission is small, about 0.5 percent.

Improperly balanced well pressures that result in sudden, uncontrolled releases of fluids from a wellbore or wellhead are called blowouts. The air pollutant emissions from blowouts depend on the amount of oil and gas released, the duration, and the occurrence of fire. Blowouts may result in the release of drilling muds and oil. From 1992 to 2002, less than 10 percent of blowouts have resulted in spilled oil, which ranged from 0.5 to 200 bbl. The duration of most blowouts is short, and half of the blowouts lasted less than half a day. An estimated 0-1 blowout is projected to occur from proposed action activities.

Hydrogen sulfide occurs sparsely throughout the GOM OCS, but principally offshore the Mississippi Delta (Louisiana), Mississippi, and Alabama. The concentrations of H_2S found to date are generally greatest in the eastern portion of the CPA, near the proposed lease sale area. Natural gas wells, offshore Mississippi/Alabama, have encountered concentrations of H_2S in the range of 20,000-55,000 ppm. The Occupational Safety and Health Administration's permissible exposure limit for H_2S is 10 ppm, which is 30 times lower than the "immediately dangerous to life and health" of 200 ppm set by the National Institute for Occupational Safety and Health. At about 500-700 ppm loss of consciousness and death can occur in 30-50 minutes. Accidents related to a proposed action involving high concentrations of H_2S could result in deaths and environmental damage. However, due to the distance of the proposed lease sale area to the coastline and that accidental releases of H_2S is a local phenomenon, any significant impacts of air quality on the coastlines would not be expected.

Summary and Conclusion

Accidents involving high concentrations of H_2S could result in deaths and environmental damage. Due to the distance of the proposed lease sale area to the coastline and that accidental releases of H_2S is a local phenomenon, any significant impacts of air quality on the coastlines would not be expected. Other emissions of pollutants into the atmosphere from accidental events as a result of a proposed action are not projected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emission height, emission rates, and the distance of the proposed lease sale area from the coastline. Increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} are estimated to be less than maximum increases allowed under the PSD Class I and II program; therefore, emissions related to a proposed action would not change onshore air quality classifications.

4.4.2. Impacts on Water Quality

Accidental events that could impact water quality include spills of crude oil, refined hydrocarbons, or chemicals used offshore. An accidental spill could occur on production or drilling facilities or from a pipeline break.

Oil spills alter and degrade water quality through the increase of petroleum hydrocarbons (alkanes, cycloalkanes, and aromatic compounds) and their various transformation/degradation products. The extent of the impact depends on the behavior and fate of oil in the water column (e.g., movement of oil, and rate and nature of weathering), which, in turn, depends on oceanographic and meteorological conditions at the time.

The National Academy of Sciences (NRC, 1985) and Boesch and Rabalais (1987) have reviewed the fate and effects of spilled oil. In general, the impacts to water quality are greatest when a spill occurs in a confined area where it persists for a long period of time. In an environment where the oil can be dispersed or diluted, the impacts are reduced. Very little information is available about the effects of an oil spill on water quality because most studies have focused on the spilled oil and its dissipation, and not on the surrounding water and its alteration. Also, spills of opportunity are few and difficult to sample on short notice. The evaluation of impacts on water quality is based on qualitative and speculative information.

A blowout would impact water quality through the resuspension and dispersion of sediments. A localized area of increased turbidity would result. A spill of SBF would settle on the ocean floor where it would eventually be microbially degraded, and it would not dissolve or disperse into the water column. The types of SBF available for use degrade at different rates and degradation could take up to several years. Temporary localized anoxia might result as the SBF degrades.

A chemical spill of zinc bromide or ammonium chloride could adversely impact water quality. Both chemicals are used intermittently in OCS activities in quantities that could potentially impact the marine environment if spilled (Boehm et al., 2001). As with an oil spill, the impact of a chemical spill is dependent upon the spill volume, and oceanographic and meteorological conditions.

4.4.2.1. Coastal Waters

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

4.4.2.2. Marine Waters

The GOM has numerous natural hydrocarbon seeps as discussed in **Chapters 3.1.2.2. and 4.1.3.4.** The marine environment is adapted to small amounts of oil released over time. **Chapter 4.3.1.2.1.**, Frequency, Magnitude, and Sources of Spilled Oil from a Proposed Action, describes the methodology used to estimate the source, number, size, location, and composition of potential future oil spills, which might result from a proposed action.

Most of the offshore oil spills assumed to occur as a result of a proposed action are estimated to be ≤1 bbl (**Table 4-31**). The most likely source of a spill ≥1,000 bbl assumed to occur as a result of a proposed action is a pipeline break. Most of the oil from a subsurface spill would likely rise to the surface and would weather and behave similarly to a surface spill, dependent upon a number of factors, particularly the characteristics of the released oil and oceanographic conditions. A subsurface oil spill resulting from a riser disconnect in the GOM rose to the surface within a 1-mi radius and within several hours of the release. However, some of the subsurface oil may be dispersed within the water column, as in the case of the *Ixtoc I* seafloor blowout.

Evidence from a recent experiment in the North Sea indicates that oil released during a deepwater blowout would quickly rise to the surface and form a slick (Johansen et al., 2001). At the surface, the oil would be mixed into the water and dispersed by wind waves.

Once the oil enters the ocean, a variety of physical, chemical, and biological processes act to disperse the oil slick, such as spreading, evaporation of the more volatile constituents, dissolution into the water column, emulsification of small droplets, agglomeration sinking, microbial modification, photochemical modification, and biological ingestion and excretion. The water quality of marine waters would be temporarily affected by the dissolved components and small oil droplets that do not rise to the surface or that are mixed down by surface turbulence. Dispersion by currents and microbial degradation remove the oil from the water column or dilute the constituents to background levels.

Four oil-spill scenarios, which assumed a 4,600-bbl spill size, were analyzed. Within three days, no slick remained for the two scenarios, which modeled oil characteristics of the EPA. For the heavy Arabian crude, about 20 percent remained in a slick after three days under winter conditions and 10 percent remained in a slick after three days under summer conditions. The amount of spilled oil that would disperse into the water column through natural processes ranges between 5 and 20 percent of the spill volume (230-920 bbl). The application of chemical dispersants to the spill would disperse an additional 25-50 percent of the spill volume, or up to 2,300 bbl, into the water column. The naturally water-soluble fraction of the spilled oil would microbially degrade within a few days. The oil droplets that are dispersed within the water degrade at a slower rate and may persist for up to 6 months (USDOC, NOAA and USDOI, MMS, 2002). The volume of oil is small relative to the amount of oil that enters the GOM through natural seeps; however, this represents a large quantity over a short period of time. Because the GOM is a large body of water, the toxic constituents of oil, such as benzene, toluene, xylene, and naphthalene, are expected to rapidly disperse to sublethal concentrations.

Summary and Conclusion

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

4.4.3. Impacts on Sensitive Coastal Environments

4.4.3.1. Coastal Barrier Beaches and Associated Dunes

The fate of accidental oil spills in the GOM depends upon where each spill originates; the chemical composition and nature of the spilled oil; and the seasonal, meteorological, and oceanographic circumstances. **Chapter 4.3.1.2.**, Risk Charaterization for Proposed Action Spills, provides estimates of the number of oil spills that might result from a proposed action, as well as oil slick dispersal and weathering characteristics. **Figure 4-18** provides the probability of an offshore spill ≥1,000 bbl occurring and contacting counties and parishes around the GOM.

In coastal Louisiana, dune-line heights range from 0.5 to 1.3 m above mean high-tide level. In Mississippi and Alabama (coastal Subarea MA-1), dune elevations exceed those in Louisiana. For tides to carry oil from a spill across and over the dunes, strong southerly winds would have to persist for an extended time prior to or immediately after the spill. Strong winds required to produce such high tides would also accelerate dispersal and spreading of the oil slick, thereby reducing impact severity at the landfall site. Significant dune contact by a spill associated with a proposed action is very unlikely. A study in Texas showed that oil disposal on sand and vegetated sand dunes had no deleterious effects on the existing vegetation or on the recolonization of the oiled sand by plants (Webb, 1988).

Oil-spill cleanup operations can affect barrier beach stability. If large quantities of sand were to be removed during spill-cleanup operations, a new beach profile and sand configuration would be established in response to the reduced sand supply and volume. The net result of these changes could be accelerated rates of shoreline erosion, especially in a sand-starved, eroding-barrier setting such as found along the Louisiana Gulf Coast. To address these possible impacts, the Gulf Coast States have established policies to limit sand removal by cleanup operations.

Based on MMS analysis of the USCG data on all U.S. coastal spills (**Chapter 4.3.1.1.1.3.**, Past Record of All (OCS and non-OCS) Spills), MMS assumes that 32 percent of coastal spills that will occur as a result of a proposed action will occur in State offshore waters 0-3 mi from shore, 4 percent will occur in offshore waters 3-12 mi from shore, and 64 percent will occur in inland waters. Of the inland spills, approximately 47 percent will occur in coastal rivers and canals, 18 percent in bays and sounds, and 35 percent in harbors. It is assumed all offshore coastal spills will contact land and proximate resources. Most inshore spills resulting from a proposed action will occur from barge, pipeline, and storage tank accidents involving transfer operations, leaks, and pipeline breaks, which are remote from barrier beaches. When transporting cargoes to terminals, oil barges make extensive use of interior waterways, which are remote from barrier beaches. Most inland spills are assumed to have no contact with barrier beaches or dunes. For an oil spill to affect a barrier beach, the oil spill would need to occur in offshore waters, on a barrier beach or dune, or inshore in the vicinity of a tidal inlet.

The September 1989 spill from a barge in the Mississippi Sound oiled the landward side of Horn Island, but not the GOM side. Similarly, the October 1992 Greenhill Petroleum Corporation oil spill (blowout during production in State waters) just inland of East Timbalier Island, Louisiana, oiled inland shorelines but did not impact barrier beaches or dunes. Other smaller inland oil spills have impacted coastal islands similarly. Inshore oil spills are assumed to contact the inland shores of a barrier island, with unlikely adverse impacts to barrier beaches or dunes.

Proposed Action Analysis

Figure 4-18 provides the probability of a spill ≥1,000 bbl occurring offshore as a result of a proposed action and reaching a Gulf Coast county or parish within 10 or 30 days. Most of the counties and parishes are at minimum risk of being contacted; the most frequently calculated probability of a spill contacting their shorelines is less than 0.5 percent. Two parishes have a risk greater than 0.5 percent—Lafourche and Plaquemines Parishes in Louisiana.

Coastal spills in offshore coastal waters or in the vicinity of Gulf tidal inlets present a greater potential risk to barrier beaches because of their close proximity. Inland spills that occur away from GOM tidal inlets are generally not expected to significantly impact barrier beaches and dunes.

Oil that makes it to the beach may be either liquid weathered oil, an oil and water mousse, or tarballs. Oil is generally deposited on beaches in lines defined by wave action at the time of landfall. Initially, components of oil on the beach will evaporate more quickly under warmer conditions. Under high tide and storm conditions, oil may return to the Gulf and be carried higher onto the beach. Oil that remains on the beach will thicken as its volatile components are lost. Thickened oil may form tarballs or aggregations that incorporate sand, shell, and other materials into its mass. Tar may be buried to varying depths under the sand. On warm days, both exposed and buried tarballs may liquefy and ooze. Oozing may also serve to expand the size of a mass as it incorporates beach materials.

Oil on the beach may be cleaned up manually, mechanically, or by using both methods. Removal of sand during cleanup is expected to be minimized to avoid significantly reducing sand volumes. Some oil will likely remain on the beach at varying depths and may persist for several years as it slowly biodegrades and volatilizes.

Summary and Conclusion

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

4.4.3.2. Wetlands

Offshore oil spills associated with a proposed action can result from platform accidents, pipeline breaks, or navigation accidents. Offshore spills are much less likely to have a deleterious effect on vegetated coastal wetlands or seagrasses than inshore spills, which are located inland. Coastal oil spills can result from storage, barge, or pipeline accidents and most of these occur as a result of transfer operations. Information on oil spills related to a proposed action is provided in **Chapter 4.3.1.2.**, Risk Charaterization for Proposed Action Spills.

The most likely locations of coastal spills are at pipeline terminals and other shore bases. Spills from support vessels could occur from navigation accidents and will be largely confined to navigation channels and canals. Slicks may quickly spread through the channel by tidal, wind, and traffic (vessel) currents. Spills that damage wetland vegetation fringing and protecting canal banks will accelerate erosion of those once protected wetlands and spoil banks (Alexander and Webb, 1987).

Primary Impacts of Oil Spills

Shoreline types have been rated (via Environmental Sensitivity Indices, (ESI's); Hayes et al., 1980; Irvine, 2000) according to their expected retention of oil and, to some extent, biological effects are believed to be aligned with oil persistence. This is evident in various low-energy environments like salt marshes. Oil has been found or estimated to persist for at least 17-20 years in such environments (Teal et al., 1992; Baker et al., 1993; Burns et al., 1993; Irvine, 2000). In some instances, where there has been further damage due to cleanup activities, recovery has been estimated to take from 8 to 100 years (Baca et al., 1987). Effects on marsh vegetation can be severe (Baca et al., 1987; Baker et al., 1993). The side effects of the depletion of marsh vegetation, which are of special concern to coastal Louisiana, is the increased erosion. Again, cleanup activities in marshes may accelerate rates of erosion and retard recovery rates, which have been reported to occur from years to decades following a spill.

The critical concentration of oil is that concentration above which impacts to wetlands will be long term and recovery will take longer than two growing seasons, and which causes plant mortality and some permanent wetland loss. Critical concentrations of various oils are currently unknown and are expected to vary broadly for wetland types and wetland plant species. Louisiana wetlands are assumed to be more sensitive to oil contact than elsewhere in the Gulf because of high cumulative stress.

Because OCS-related pipelines traverse wetland areas, pipeline accidents could result in high concentrations of oil directly contacting limited areas of wetland habitats (Fischel et al., 1989). Based on data from Mendelssohn et al. (1990), recovered vegetation is expected to be the ecologically functional equivalent of unaffected vegetation. A reduction in plant density was therefore studied as the principle impact from spills. Mendelsohn and his associates demonstrated that oil could persist in the soil for greater than 5 years if a pipeline spill occurs within the interior of a wetland where wave-induced or tidal flushing is not regular or vigorous.

Numerous investigators have studied the immediate impacts of oil spills on wetland habitats in the Gulf and other wetland habitats similar to those affected by OCS activities, resulting in a range of conclusions. Some of these inconsistencies can be explained by differences in oil concentrations contacting vegetation, kinds of oil spilled, types of vegetation affected, season of year, preexisting stress level of the vegetation, soil types, and numerous other factors. In overview, the data suggest that light-oiling impacts will cause plant dieback with recovery within two growing seasons without artificial replanting. Most impacts to vegetation are considered short term and reversible (Webb et al., 1985; Alexander and Webb, 1987; Lytle, 1975; Delaune et al., 1979; Fischel et al., 1989). Because OCS-related pipelines traverse wetland areas, pipeline accidents could result in high concentrations of oil directly contacting areas of wetland habitats (Fischel et al., 1989) or open waters. The fluid nature of the oil, water levels, weather, and the density of the vegetation would limit the area of interior wetlands contacted by any given spill.

In coastal Louisiana, the critical concentration of oil resulting in long-term impacts to wetlands is assumed to be 0.1 l/m^2. Concentrations less than this will cause dieback of the aboveground vegetation for one growing season, but limited mortality. Higher concentrations will cause mortality of contacted vegetation, but 35 percent of the affected area will recover within 4 years. Oil will persist in the wetland soil for at least 5 years. After 10 years, permanent loss of 10 percent of the affected wetland area will be expected as a result of accelerated landloss indirectly caused by the spill. If a spill contacts wetlands exposed to wave attack, additional and accelerated erosion will occur, as documented by Alexander and Webb (1987).

Wetlands in Texas, Mississippi, Alabama, and Florida occur on a more stable substrate and receive more inorganic sediment per unit of wetland area than wetlands in Louisiana. These wetlands have not experienced the extensive alterations caused by rapid submergence rates and extensive canal dredging that affect Louisiana wetlands. The examinations of Webb and colleagues (Webb et al., 1981 and 1985; Alexander and Webb, 1983 and 1985) are used to evaluate impacts of spills in these settings. For wetlands along more stable coasts, such as in Texas, the critical oil concentration is assumed to be

1.0 l/m^2 (Alexander and Webb, 1983). Concentrations below the expected 1.0 l/m^2 will result in short-term, aboveground dieback for one growing season. Concentrations above this will result in longer-term impacts to wetland vegetation, including plant mortality extensive enough to require recolonization.

Using these studies, the following model was developed. For every 50 bbl of oil spilled and contacting wetlands, approximately 2.7 ha of wetland vegetation will experience dieback. Thirty percent of these damaged wetlands are assumed to recover within 4 years; 85 percent within 10 years. About 15 percent of the contacted wetlands are expected to be converted permanently to open-water habitat.

Secondary Impacts of Oil Spills

The cleanup of oil spills in coastal marshes remains a problematic issue because wetlands can be extremely sensitive to the disturbances associated with cleanup activities. Once a marsh is impacted by an oil spill, a decision must be made concerning the best method of cleanup and restoration. Often the best course of action is to let the impacted area(s) recover naturally in order to avoid secondary impacts associated with the cleanup process (McCauley and Harrel, 1981; Long and Vandermeulen, 1983: Getter et al., 1984; Baker et al., 1993; Mendelssohn et al., 1993). Foot traffic and equipment traffic on the marsh surface during cleanup operations are considered secondary impacts that can have significant adverse effects on the recovery of the marsh by trampling vegetation, accelerating erosion, and burying oil into anaerobic soils where it may persist for years (Getter et al., 1984).

Proposed Action Analysis

Figure 4-18 provides the results of the Oil Spill Risk Analysis (OSRA) model that calculated the probability of a spill ≥1,000 bbl occurring offshore as a result of a proposed action and reaching a Gulf Coast county or parish within 10 or 30 days. Most of the counties and parishes are at minimum risk of being contacted; the most frequently calculated probability of a spill contacting their shorelines is less than 0.5 percent. Two parishes have a risk greater than 0.5 percent—Lafourche and Plaquemines Parishes in Louisiana. Should such a contact occur, oiling will be very light and spotty with short-term impacts to vegetation.

Coastal spills are the greater spill threat to interior wetlands than offshore spills. **Table 4-32** shows that 12-16 coastal spills are projected as a result of a proposed action. Coastal spills are expected to occur near pipeline terminals (Louisiana, near Timbalier Bay, Grand Isle, or east of the Mississippi River) or the major service bases (Venice and Fourchon, Louisiana, and in Mobile, Alabama).

Summary and Conclusion

Offshore oil spills resulting from a proposed action are not expected to significantly damage inland wetlands; however, if an inland oil spill related to a proposed action occurs, some impact to wetland habitat would be expected. Although the impact may occur generally over coastal regions, the impact has the highest probability of occurring in the coastal regions where oil is handled (Louisiana, near Timbalier Bay, Grand Isle, or east of the Mississippi River) and major service bases (Venice and Fourchon, Louisiana, and in Mobile, Alabama).

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

4.4.3.3. Seagrass Communities

Seagrass communities along the Gulf Coast are widely scattered beds in shallow, high-salinity coastal lagoons and bays. The vast majority of seagrass communities present in the GOM occur in the nearshore coastal zones of Florida; in Texas, extensive seagrass beds are found in both the Upper and Lower Laguna Madre along the Texas coast, as well as Baffin Bay.

Central Gulf Coast seagrass beds are restricted to small shallow areas behind barrier islands in Mississippi and the Chandeleur Sounds and to smaller, more scattered populations elsewhere. Lower-salinity seagrass beds are found inland and discontinuously throughout the coastal zone of Louisiana and Mississippi. Most of the seagrass beds located between the Southwest Pass of the Mississippi River and Cape San Blas, Florida, are inland of the barrier shorelines.

Accidental impacts associated with a proposed action that could adversely affect seagrass habitat include oil spills associated with the transport and storage of oil (**Chapter 4.3.1.2.**, Risk Charaterization for Proposed Action Spills). The degree of impact from oil spills depends on the location of the spill, oil slick characteristics, water depth, currents, and weather. Offshore oil spills that occur in the proposed action areas are much less likely to contact seagrass communities than are inshore spills because they are generally protected by barrier islands, peninsulas, sand spits, and currents.

Some oils can emulsify; suspended particles in the water column will adsorb oil in a slick, decreasing the oil's suspendability and causing some of the oil to be dispersed down into the water column. Typically, seagrass communities reduce water velocity among the vegetation as well as for a short distance above it. Minute oil droplets, whether or not they are bound to suspended particulate, may adhere to the vegetation or other marine life, be ingested by animals, or settle onto bottom sediments. In all of these situations, oil has a limited life because it will be degraded chemically as well as biologically. Microbes, which are found in all marine environments, are considered the greatest degraders of oil (Zieman et al., 1984); therefore, because estuaries have a greater suspended particulate load and greater microbial population, oil will degrade more rapidly (Lee, 1977). Oil that penetrates deeply into the sediments is less available for dissolution, oxidation, or microbial degradation. If buried, oil may be detectable in the sediments for 5 years or more, depending upon the circumstances.

The cleanup of slicks in shallow or protected waters (<5 ft deep) may be performed using johnboats or booms, anchors, and skimmers mounted on boats or shore vehicles. Personnel assisting in oil-spill cleanup in water shallower than 3-4 ft may readily wade through the water to complete their tasks (**Chapter 4.3.1.1.5.**, Spill-Response Capabilities).

Proposed Action Analysis

A complete illustration of the projected probabilities of one or more oil spills ≥1,000 bbl occurring due to a proposed action is found in **Figure 4-19** for the entire Gulf Coast.

The risk of an offshore spill ≥1,000 bbl occurring and contacting coastal counties and parishes was calculated by MMS's oil-spill trajectory model. Counties and parishes are used as an indicator of the risk of an offshore spill reaching sensitive coastal environments. **Figure 4-18** provides the results of the OSRA model that calculated the probability of a spill ≥1,000 bbl occurring offshore as a result of a proposed action and reaching a county or parish. The probabilities are very small. Most of the counties and parishes are at minimum risk of being contacted; the most frequently calculated probability of a spill contacting their shorelines is <0.5 percent. Lafourche and Plaquemines Parishes, Louisiana, have the greatest risk of a spill occurring and contacting their shoreline. **Figure 4-19** shows that the Florida Panhandle, Big Bend, Southwest Beach Area, and Ten Thousand Islands Area resources each have a <0.5 percent probability of an offshore spill occurrence and contact. The more inland seagrass beds are generally protected from offshore spills by barrier islands, shoals, shorelines, and currents. These beds are generally more susceptible to contact by inshore spills, which have a low probability of occurrence. Inshore vessel collisions may release fuel and lubricant oils, and pipeline ruptures may release crude and condensate oil. In either case, seagrass beds grow below the water surface. In this region of the Gulf, they remain submerged due to the micro-tides that occur there. Their regenerative roots and rhizomes are buried in the water bottom, where they are further protected (**Chapter 3.2.1.3.**, Seagrass Communities). Should an oil slick pass over these seagrass communities, damage would occur if an unusually low tide were to occur, causing contact between the two. A more damaging scenario would be that a slick might pass over and remain over a submerged bed of vegetation in a protected embayment during typical fair-weather conditions. This would reduce light levels in the bed. If light reduction continues for several days, chlorophyll content in the leaves will be reduced (Wolfe et al., 1988), causing the grasses to yellow and reducing their productivity. Shading by an oil slick of the sizes described should not last long enough to cause mortality, depending upon the slick thickness, currents, weather, and the nature of the embayment. In addition, a slick that remains over seagrass beds in an embayment also will reduce or eliminate oxygen exchange between the air and the water of the embayment. Oxygen depletion is a serious problem for seagrasses (Wolfe et al., 1988). If currents flush little oxygenated water between the embayment and the larger waterbody and if the biochemical oxygen demand (BOD) is high, as it would be in a shallow water bed of vegetation, and then enhanced by an additional burden of oil, the grasses and related epifauna will be stressed and perhaps suffocated. In this situation, the degree of suffocation will depend upon the reduced oxygen concentration and duration of those conditions. Oxygen concentrations and their duration depend upon currents, tides, weather, temperature, percentage of slick coverage, and BOD.

Should weather conditions or currents increase water turbulence sufficiently, a substantial amount of oil from the surface slick will be dispersed downward into the water column. Suspended particles in the water column will adsorb to the dispersed oil droplets as well as to some of the oil in the sheen. Typically, submerged vegetation reduces water velocity among the vegetation and enhances sedimentation. Typically, this will not cause long-term or permanent damage to the seagrass communities. Some dieback of leaves would be expected for one growing season. In a severe case where high concentrations of hydrocarbons are mixed into the water column, the diversity or population of epifauna and benthic fauna found in seagrass beds could be impacted. Seagrass epiphytes are sessile plants and animals that grow attached to their seagrass host; they play an important role in the highly productive seagrass ecosystem. The small animals, such as amphipods, limpets and snails, would likely show more lethal effects than the epiphytic plant species. The lack of grazers could lead to a short-term (up to 2 years) imbalance in the seagrass epifaunal community and cause stress to the seagrass due to epiphyte overgrowth. No permanent loss of seagrass habitat is projected to result from the spill unless an unusually low tidal event allows direct contact between the slick and the vegetation.

No significant burial of the oil is expected to occur from any one spill. Oil measured at some depth usually means the area is impacted by chronic oil contamination, new sediments are spread over the area, or heavy foot or other traffic works the oil into the bottom sediment. The cleanup of slicks that settle over seagrass communities in shallow waters may damage the areas where props, anchors, boat bottoms, treads, wheels, trampling, and dragging booms crush or dig up plants.

Summary and Conclusion

Should a spill ≥1,000 bbl occur offshore from activities resulting from a proposed action, the seagrass communities have a <0.5 percent probability of contact within 10 or 30 days (**Figure 4-19**). Because of the location of most submerged aquatic vegetation, inshore spills pose the greatest threat to them. Such spills may result from either vessel collisions that release fuel and lubricants or from pipelines that rupture. If an oil slick settles into a protective embayment where seagrass beds are found, shading may cause reduced chlorophyll production; shading for more than about 2 weeks could cause thinning of leaf density. Under certain conditions, a slick could reduce dissolved oxygen in an embayment and cause stress to the bed and associated organisms due to reduced oxygen conditions. These light and oxygen problems can correct themselves once the slick largely vacates the embayment and light and oxygen levels are returned to pre-slick conditions.

Increased water turbulence due to storms or vessel traffic will break apart the surface sheen and disperse some oil into the water column, as well as increase suspended particle concentration, which will adsorb to the dispersed oil. Typically, these situations will not cause long-term or permanent damage to the seagrass beds, although some dieback of leaves is projected for one growing season. The diversity or population of epifauna and benthic fauna found in seagrass beds may be reduced for up to 2 years, depending on several factors including type of oil (refined products are more toxic), time of year, amount of mixing, and weathering. No permanent loss of seagrass is projected to result from oil contact, unless an unusually low tidal event allows direct contact between the slick and vegetation.

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

4.4.4. Impacts on Sensitive Offshore Benthic Resources

4.4.4.1. Continental Shelf Resources

4.4.4.1.1. Live Bottoms (Pinnacle Trend)

Oil spills have the potential to foul benthic communities and cause lethal or sublethal effects on live-bottom organisms. Measurable amounts of oil from a surface spill can be driven 20 m into the water column. At the water depth of the pinnacle trend, spilled oil would be at concentrations several orders of magnitude lower than the amount shown to have an effect on marine organisms. Subsurface oil spills from pipeline ruptures would have a greater potential to bring high concentrations of oil in contact with the biota of the pinnacles. The concentrations of subsurface-released oil reaching this biota would depend on the severity and the proximity of the spill and on the speed and direction of prevailing subsurface currents.

Proposed Action Analysis

The pinnacles are located in the Main Pass and Viosca Knoll lease areas off Mississippi and Alabama, over 28 mi from the proposed lease sale area. Any surface oil spill resulting from a proposed action would likely have no impact on the biota of the pinnacle trend because the crests of these features are much deeper than 20 m.

Pipelines in the pinnacle trend area may transport proposed action production. All evidence to date indicates that accidental oil discharges that occur at the seafloor would rise in the water column, surfacing almost directly over the source location (**Chapter 4.3.1.2.2.**, Fate of Spilled Oil), and thus not impact pinnacles. The risk of weathered components from a surface slick reaching pinnacles in any measurable concentrations would be very small. Natural containment and dispersion of oil, as well as the widespread nature of the biota, would limit the severity and the extent of the area impacted by subsurface spills. A subsurface pipeline oil spill (≥1,000 bbl) could result in the most deleterious impacts on the biota of pinnacles, particularly if the oil impinges directly on the pinnacles. Yet, the biota of the pinnacles would probably recover once the oil was cleared. There are no data to date that reveal the effects or recovery time associated with oil spills on pinnacle trend features.

Summary and Conclusion

No pinnacles are located in the proposed lease sale area; however, pipelines in the pinnacle trend may transport proposed action production. A subsurface oil spill would rise in the water column, surfacing almost directly over the source location, and thus not impacting pinnacles. Because of this and the small size and dispersed nature of many of the features, impacts from accidental events as a result of a proposed action are estimated to be infrequent. No community-wide impacts are expected. Oil spills would not be followed by adverse impacts (e.g., high elevated decrease in live cover) because of the depth of the features and dilution of spills (by currents and the quickly rising oil). The frequency of impacts on the pinnacles would be rare, and the severity should be slight because of the widespread nature of the features.

4.4.4.2. Continental Slope and Deepwater Resources

4.4.4.2.1. Chemosynthetic Communities

The primary accidental event that could impact chemosynthetic communities is a blowout. A blowout at the seafloor could create a crater and could resuspend and disperse large quantities of sediments within a 300-m (984-ft) radius from the blowout site, thus potentially impacting any organisms located within that distance. The application of avoidance criteria for chemosynthetic communities required by NTL 2000-G20 should preclude the impact of a blowout to a distance of 457 m (1,500 ft).

Oil and chemical spills are not considered to be a potential source of measurable impacts on chemosynthetic communities because of the water depths at which these communities are located. Oil spills at the surface would tend not to sink. The potential for weathered components from a surface slick (or midwater portions of spilled oil not reaching the surface) returning to the bottom and reaching a chemosynthetic community in any measurable volume would be very small. Impacts to chemosynthetic communities from any oil released from a subsea spill would be a remote possibility. Release of oil associated with a blowout or pipeline break should not present a possibility for impact to chemosynthetic communities located a minimum of 457 m (1,500 ft) from well sites. All known reserves in the GOM to date have specific gravity characteristics that would preclude oil from sinking immediately after release at a blowout site. All evidence to date indicates that oil spills that occur at the seafloor from either a blowout or pipeline break would rise in the water column reaching the sea surface and, thus, not impacting the benthos.

The presence of oil may not have an impact because these communities live among oil and gas seeps; however, natural seepage is very constant and at very low rates as compared to the potential volume of oil released from a blowout or pipeline rupture. All seep organisms also require unrestricted access to oxygenated water at the same time as exposure to hydrocarbon energy sources.

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

Proposed Action Analysis

For water depths between 1,600 and 2,400 m, 0-1 blowout is estimated and 0-1 blowout is estimated for water depths over 2,400 m. The application of avoidance criteria for chemosynthetic communities required by NTL 2000-G20 should preclude the impact of a blowout to a distance of 457 m (1,500 ft), which is beyond the distance of expected benthic disturbance. Resuspended bottom sediments transported by near-bottom currents could reach chemosynthetic comminuties located beyond 457 m and potentially impact them by burial or smothering.

The risk of various sizes of oil spills estimated to occur as a result of a proposed action is discussed in **Chapter 4.3.1.2.**, Risk Charaterization for Proposed Action Spills. The chance of one or more spills ≥1,000 bbl occurring from activities supporting a proposed action is 9-12 percent. The probability of oil in any measurable concentration reaching depths of 1,600 m or greater would be less. The chance of one spill ≥1,000 bbl occurring from an OCS pipeline as a result of a proposed action is 8-10 percent. All evidence to date indicates that accidental oil discharges that occur at the seafloor from a pipeline or blowout would rise in the water column, and thus not impact the benthos. The risk for weathering components from a surface slick reaching the benthos in any measurable concentrations would be very small.

Summary and Conclusion

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

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

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

4.4.4.2.2. Nonchemosynthetic Communities

A blowout at the seafloor could create a crater and could resuspend and disburse large quantities of bottom sediments within a 300-m radius from the blowout site, thus potentially impacting any organisms located within that distance. Physical disturbance or destruction of a limited area of benthos or to a limited number of megafauna organisms, such as brittle stars, sea pens, or crabs, would not result in a major impact to the deepwater benthos ecosystem as a whole. Even in situations where substantial burial of typical benthic communities occurred, recolonization from populations from neighboring substrate would be expected over a relatively short period of time for all size ranges of organisms, in a matter of days for bacteria, and probably less than one year for most all macrofauna species.

Oil and chemical spills are not considered to be a potential source of measurable impacts to nonchemosynthetic deepwater benthic communities because of the water depths at which these communities are located. Oil spills at the surface would tend not to sink. The potential for weathered components from a surface slick (or midwater portions of spilled oil not reaching the surface) returning to the bottom and reaching a deepwater benthic community in any measurable volume would be very small. Impacts to these communities from any oil released from a subsea spill would be a remote possibility. All known reserves in the GOM to date have specific gravity characteristics that would preclude oil from sinking immediately after release at a blowout site. All evidence to date indicates that oil spills that occur at the seafloor from either a blowout or pipeline break would rise in the water column reaching the sea surface and, thus, not impacting the benthos.

Under the current review procedures for chemosynthetic communities, carbonate outcrops (depicted as high reflectivity-surface anomalies on 3D seismic survey maps) are targeted as one possible indication that chemosynthetic seep communities are nearby. Any unique nonchemosynthetic communities that may be associated with carbonate outcrops or other topographical features would be avoided via this review along with the chemosynthetic communities. Typically, all areas suspected of being hard bottom are avoided as a potential geological hazard for any well sites. Water depths (1,600-2,400 m) of the proposed lease sale area would automatically trigger the NTL 2000-G20 evaluation described above.

Proposed Action Analysis

For water depths between 1,600 and 2,400 m, 0-1 blowout is estimated and 0-1 blowout for water depths below 2,400 m.

The risk of various sizes of oil spills occurring in the proposed lease sale area is discussed in **Chapter 4.3.1.2.**, Risk Charaterization for Proposed Action Spills. The probability of a spill resulting in any measurable concentrations of oil in sediments at depths of 1,600 m or greater is very small.

Summary and Conclusion

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

Deepwater coral habitats and other potential hard-bottom communities not associated with chemosynthetic communities appear to be very rare. These unique communities are distinctive and similar in nature to protected pinnacles and topographic features on the continental shelf. Any hard substrate communities located in deep water would be particularly sensitive to impacts. Impacts to these sensitive habitats could permanently prevent recolonization with similar organisms requiring hard substrate, but adherence to the provisions of NTL 2000-G-20 should prevent all but minor impacts to hard-bottom communities beyond a distance from a well site of 454 m (1,500 ft).

A proposed action is expected to cause little damage to the ecological function or biological productivity of the widespread, typical, deep-sea benthic communities.

4.4.5. Impacts on Marine Mammals

Blowouts

Improperly balanced well pressures that result in sudden, uncontrolled releases of fluids from a wellhead or wellbore are called blowouts. Blowouts can occur during any phase of development: exploratory drilling, development drilling, production, completion, or workover operations. In the event of a blowout, the eruption of gases and fluids may generate significant pressure waves and noise that may harass, injure, or kill marine mammals, depending on their proximity to the accident. The effects of noise on marine mammals are discussed at length in **Chapter 4.2.1.5.**, Impacts on Marine Mammals. However, the primary concern in a blowout is the loss of oil, which occurred in less than 10 percent of blowouts.

Oil Spills

Each major grouping of marine mammals (e.g., manatees and dugongs, and baleen and toothed whales) confronts spilled hydrocarbons in different ways. Oil spills could affect marine mammals through various pathways: surface contact, inhalation, ingestion, and baleen fouling (Geraci, 1990). Much of the information on the effects of oil on marine mammals comes from studies of fur-bearing marine mammals (e.g., seals and sea lions, and sea otters). Sea otters exposed to the *Exxon Valdez* spill experienced high incidences of emphysema, petroleum hydrocarbon toxicosis, abortion, and stillbirths (Williams and Davis, 1995). Direct contact with oil and/or tar for cetaceans can lead to irritation and damage of skin and soft tissues (such as mucous membranes of the eyes), fouling of baleen plates so as to hinder the flow of water and interfere with feeding, and incidental ingestion of oil and/or tar. Studies by Geraci and St. Aubin (1982 and 1985) have shown that the cetacean epidermis functions as an effective barrier to noxious substances found in petroleum. Unlike other mammals, penetration of such substances in cetacean skin is impeded by tight intercellular bridges, the vitality of the superficial cells, the thickness of the epidermis, and the lack of sweat glands and hair follicles (Geraci and St. Aubin, 1985). The cetacean epidermis is nearly impenetrable, even to the highly volatile compounds in oil, and when skin is breached, exposure to these compounds does not impede the progress of healing (Geraci and St. Aubin, 1985). Cetacean skin is free from hair or fur, which in other marine mammals, such as pinnipeds and otters, tends to collect oil and/or tar, which subsequently reduces the insulating properties of the fur (Geraci, 1990). Dolphins maintained at a captive site in Sevastopol, Ukraine, that were exposed to petroleum products initially exhibited a sharp depression of food intake along with an excitement in behavior, eye inflammation, and changes in hemoglobin as well as erythrocyte content (Lukina et al., 1996). Prolonged exposure to oil led to a depression of those blood parameters, as well as changes in breathing patterns and gas metabolism, while nervous functions became depressed and skin injuries and burns appeared (Lukina et al., 1996). Experiments with harbor porpoise in similar conditions possibly resulted in aspiration pneumonia (Lukina et al., 1996). Dolphins exposed to oil at a Japanese aquarium that draws seawater from the ocean began developing cloudy eyes (Reuters, 1997).

Fresh crude oil or volatile distillates release toxic vapors that, when inhaled, can lead to irritation of respiratory membranes, lung congestion, and pneumonia. Subsequent absorption of volatile hydrocarbons into the bloodstream may accumulate into such tissues as the brain and liver, causing neurological disorders and liver damage (Geraci and St. Aubin, 1982; Hansen, 1985; Geraci, 1990). Toxic vapor concentrations just above the water’s surface (where cetaceans draw breath) may reach critical levels for the first few hours after a spill, prior to evaporation and dispersion of volatile aromatic hydrocarbons and other light fractions (Geraci and St. Aubin, 1982).

Trained, captive bottlenose dolphins exposed to oil could not detect light oil sheen but could detect thick dark oil based on visual, tactile, and presumably echolocation cues (Geraci et al., 1983; Smith et al., 1983). Studies of captive dolphins also showed that they completely avoided surfacing in slick oil after a few brief, initial tactile encounters. Reactions of free-ranging cetaceans to spilled oil appear varied, ranging from avoidance to apparent indifference (reviewed by Geraci, 1990; Smultea and Würsig, 1991). In contrast to captive dolphins, bottlenose dolphins during the *Mega Borg* spill did not consistently avoid entering slick oil, which could increase their vulnerability to potentially harmful exposure to oil chemicals (Smultea and Würsig, 1991 and 1995). It is possible that some overriding behavioral motivation (such as feeding) induced dolphins to swim through the oil, that slick areas were too large for dolphins to feasibly avoid, or that bottlenose dolphins have become accustomed to oil due to the extent of oil-related activity in the GOM (Smultea and Würsig, 1995). The latter could result in temporary displacement from migratory routes. After the *Exxon Valdez* spill, killer whales did not appear to avoid oil; however, none were observed in heavier slicks of oil (Matkin et al., 1994). It is unknown whether animals in some cases are simply not affected by the presence of oil, or perhaps are even drawn to the area in search of prey organisms attracted to the oil's protective surface shadow (Geraci, 1990). The probable effects on cetaceans swimming through an area of oil would depend on a number of factors, including ease of escape from the vicinity, the health of the individual animal, and its immediate response to stress (Geraci and St. Aubin, 1985).

Spilled oil can lead to the localized reduction, extirpation, or contamination of prey species. Prey species, such as zooplankton, crustaceans, mollusks, and fishes, may become contaminated by direct contact and/or by ingesting oil droplets and tainted food. Marine fishes are known to take up petroleum hydrocarbons from both water and food, though apparently do not accumulate high concentrations of hydrocarbons in tissues, and may transfer them to predators (Neff, 1990). Cetaceans may consume oil-contaminated prey (Geraci, 1990) or incidentally ingest floating or submerged oil or tar. Hydrocarbons may also foul the feeding apparatus of baleen whales (though laboratory studies suggest that such fouling has only transient effects) (Geraci and St. Aubin, 1985). In general, the potential for ingesting oil-contaminated prey organisms with petroleum-hydrocarbon, body-burden content is highest for benthic feeding whales and pinnipeds. The potential is reduced for plankton-feeding whales and is lowest for fish-eating whales and pinnipeds (Würsig, 1990). Baleen whales occurring in the GOM feed on small pelagic fishes (such as herring, mackerel, and pilchard) and cephalopods (Cummings, 1985). An analysis of stomach contents from captured and stranded odontocetes suggest that they are deep-diving animals, feeding predominantly on mesopelagic fish and squid or deepwater benthic invertebrates (Heyning, 1989; Mead, 1989). Delphinids feed on fish and/or squid, depending upon the species (Mullin et al., 1991).

As noted by St. Aubin and Lounsbury (1990), there have been no experimental studies and only a handful of observations suggesting that oil has harmed any sirenian. Dugongs (relatives of the manatees) have been found dead on beaches after the Gulf War oil spill and the 1983 *Nowruz* oil spill caused by the Iran-Iraq War (Preen, 1991; Sadiq and McCain, 1993). Some dugongs were sighted in the oil sheen after the Gulf War (Pellew, 1991). Four types of impacts to dugongs from contact with oil include asphyxiation due to inhalation of hydrocarbons, acute poisoning due to contact with fresh oil, lowering of tolerance to other stress due to the incorporation of sublethal amounts of petroleum fractions into body tissues, and nutritional stress through damage to food sources (Preen, 1989, in Sadiq and McCain 1993). Manatees concentrate their activities in coastal waters, often resting at or just below the surface, which may bring them in contact with spilled oil (St. Aubin and Lounsbury, 1990). Manatees are nonselective, generalized feeders that might consume tarballs along with their normal food; such occurrences have been rarely reported (review in St. Aubin and Lounsbury, 1990). A manatee might also ingest fresh petroleum, which some researchers have suggested might interfere with the manatee's secretory activity of their unique gastric glands or harm intestinal flora vital to digestion (Geraci and St. Aubin, 1980; Reynolds, 1980). Oil spills within the confines of preferred river systems and canals, particularly during winter (when the animals are most vulnerable physiologically), could endanger local populations. Manatees able to escape such areas might be forced into colder waters, where thermal stress could complicate the effects of even brief exposure to oil (St. Aubin and Lounsbury, 1990). Such a scenario would expose them to increased vessel traffic, the primary cause of unnatural manatee deaths. This scenario is not one likely to be associated with offshore production or transportation of petroleum. The greater risk is from coastal accidents. 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.

Indirect consequences of oil pollution on marine mammals include those effects that may be associated with changes in the availability or suitability of prey resources (Hansen, 1992). Depending on the spatial scale and magnitude of an oil spill, diminished prey abundance and availability may cause marine mammal predators to move to less suitable areas and/or consume less suitable prey. In either case, the impact can be significant to a marine mammal population or stock. No long-term bioaccumulation of hydrocarbons have been demonstrated; however, an oil spill may physiologically stress an animal (Geraci and St. Aubin, 1980), making them more vulnerable to disease, parasitism, environmental contaminants, and/or predation.

Spill-Response Activities

Spill-response activities include the application of dispersant chemicals to the affected area (**Chapter 4.3.1.1.5.**, Spill-Response Capabilities). Dispersant chemicals are designed to break oil on the water's surface into minute droplets, which then break down in seawater. Essentially nothing is known about the effects of oil dispersants on cetaceans, except that removing oil from the surface would reduce the risk of contact and render it less likely to adhere to skin, baleen plates, or other body surfaces (Neff, 1990). The acute toxicity of most oil dispersant chemicals is considered to be low relative to the constituents and fractions of crude oil and refined products, and studies have shown that the rate of biodegradation of dispersed oil is equal to or greater than that of undispersed oil (Wells, 1989). A variety of aquatic organisms readily accumulates and metabolizes surfactants from oil dispersants. Enzymatic hydrolysis of the surfactant yields hydrophilic and hydrophobic components. The former probably are excreted via the gills and kidneys, whereas the latter accumulate in the gallbladders of fish and are excreted very slowly (Neff, 1990). Metabolism of surfactants is thought to be rapid enough that there is little likelihood of food chain transfer from marine invertebrates and fish to predators, including marine mammals (Neff, 1990).

Biodegradation is another process used for removing petroleum hydrocarbons from the marine environment, utilizing chemical fertilizers to augment the growth of naturally occurring hydrocarbon-degrading microorganisms. Toxic effects of these fertilizers on cetaceans are presently unknown.

Proposed Action Analysis

The potential causes, sizes, and probabilities of oil spills that could occur during drilling, production, and transportation operations associated with a proposed action are presented in **Chapter 4.3.1.2.**, Risk Charaterization for Proposed Action Spills. **Table 4-32** lists estimates for spill magnitude and abundance for GOM coastal (i.e., State) waters as a result of a proposed action. The estimates of spill magnitude and abundance for Federal OCS waters, as a result of a proposed action, are given in **Table 4-31**. Qualitative inspection of historic spill data indicates that the following would likely occur as a result of a proposed action: many, frequent, very small spills; some, infrequent, small spills; few, rare, moderate spills; and no large spills. The assessment of spill frequency (i.e., frequent, infrequent, unlikely) is relative to the life span of a proposed action.

Oil spills originating in coastal waters (as opposed to spills immigrating to coastal waters from offshore) as a result of a proposed action are assumed to encroach upon adjacent coastal lands. Spill estimates (**Table 4-32**) indicate that coastal spills would introduce 13-162 bbl of oil into coastal waters over the life span of a proposed action. It is expected that oil resources produced as a result of a proposed action would be transported to Louisiana; thus, coastal spills would occur in Louisiana waters. Based on analysis, MMS assumes that there would be some very small (<1 bbl) spills and few small (>1 and <50 bbl) spills, with no moderate (>50 and <1,000 bbl) or large (≥1,000 bbl) spills in Louisiana coastal waters over the life of a proposed action. Though not assumed, a large spill (≥1,000 bbl) is a possibility, and pipelines pose the greatest risk for such an event.

Coastal, as well as neritic (<200-m depth) and oceanic (>200-m depth), waters may also be impacted by offshore oil spills. As indicated in **Table 4-31**, MMS assumes a range of occurrence, from frequent <1 bbl spills to no large spills. However, there is a 9-12 percent chance of an oil spill ≥1,000 bbl occurring from an offshore operation as a result of a proposed action. A large spill (≥1,000 bbl) in the EPA could impact the waters and coastline of any of the five states bordering the GOM, depending on a variety of factors including but not limited to currents, wind, amount, and weathering of oil. The greatest risk from a large offshore spill resulting from a proposed action is to western Louisiana waters and coastline, with a 3-4 percent chance of impact within 30 days of the spill (**Table 4-34**, **Figure 4-21**). As in coastal waters, pipelines are the most likely source of a large spill in neritic waters. The most likely source of small spills is platforms. Pipeline ruptures pose the greatest risk of spills in the oceanic waters. Based on historic spill rates relative to the volume of oil produced, MMS estimates that the total volume of oil spilled in Federal offshore waters as a result of a proposed action is 500-700 bbl of oil over the life span of the lease. This estimate, coupled with the coastal water oil-spill estimate given above, results in a total estimated volume of 513-862 bbl of oil that may be introduced into GOM offshore and coastal environments from a proposed action over the life of the leases.

Spills originating in or migrating through coastal waters may impact bottlenose dolphins, Atlantic spotted dolphins, or the West Indian manatee. The bottlenose dolphin is by far the most abundant marine mammal in the coastal and neritic waters of the GOM. Although this species can range out to deep, oceanic water, it is most commonly associated with coastal environments. The Atlantic spotted dolphin does not normally inhabit the very shallow coastal waters but is common in the GOM neritic environment. Both of these species could by impacted by a large offshore spill resulting from a proposed action. **Figure 4-21** illustrates the risk probabilities, with the highest in the western Louisiana/Mississippi/Alabama marine mammal habitat area where, over the life of a proposed action, there is a 2-3 percent chance of contact within 10 days of an offshore spill and a 3-4 percent chance of contact within 30 days of the spill. The endangered West Indian manatee inhabits coastal and inland waters and could be impacted by an offshore oil spill from a proposed action. As is illustrated in **Figure 4-22**, the risk is small but increases moving west from Florida to Louisiana. Manatees have historically been associated with Florida waters; however, reports of manatee sightings from other Gulf Coast States are increasing. In 2001, there were 17 manatee sightings/strandings reported in Alabama, 3 in Mississippi, 6 in Louisiana and 8 in Texas. It is unclear whether this increase is due to better reporting methods or an actual shift in manatee habitat. However, there is the possibility of an offshore oil spill impacting manatees in waters outside of Florida.

The greatest diversity and abundance of cetaceans inhabiting the GOM is found in its oceanic and OCS waters. At least 17 species of whales and dolphins have been documented in the EPA. Individual cetaceans are not necessarily randomly distributed in the offshore environment, but are instead prone to forming groups of varying sizes. In some cases, several species may be found aggregating in the same area. Large spills, particularly those continuing to flow fresh hydrocarbons into oceanic and/or outer shelf waters for extended periods (days, weeks, months), pose an increased likelihood of impacting cetacean populations inhabiting these waters. Based on abundance estimates and a hypothetical spill surface area, spills occurring in these waters could impact more species and more individuals than coastal spills. The only commonly occurring endangered marine mammal in the GOM, the sperm whale, uses oceanic waters as principle habitat, and the northern GOM is known to support approximately 300-500 of these animals. Based on research to date, the Mississippi Canyon and the DeSoto Canyon are areas of particular interest where sperm whales are known to occur and congregate.

There is an extremely small probability that a single cetacean would encounter an oil slick resulting from a single, small spill. Increasing the size of a slick or factoring in the number of estimated spills over the life of a proposed action increases the likelihood that an animal would encounter a single slick during its lifetime as many cetacean species are long-lived and may traverse throughout waters of the northern GOM. The likelihood that a cetacean population may encounter an oil slick resulting from a single spill during the lease life is greater than that of a single individual encountering a slick during its lifetime. It is impossible to predict precisely which cetacean species, population, stock or individuals would be impacted, to what magnitude, or in what numbers, since each species has unique distribution patterns in the GOM and because of difficulties attributed to predicting when and where oil spills would occur. Given the distribution of available leases and pipelines associated a proposed action and the distribution of marine mammals in the northern GOM, the impact of an oil spill must be considered relative to the region and period of exposure. Spills of any size degrade water quality, and residuals become available for bioaccumulation within the food chain. Slicks may spread at the sea surface or may migrate underwater from the seafloor through the water column and never broach the sea surface. Regardless, a slick is an expanding, but aggregated mass of oil that, with time, would disperse into smaller units as it evaporates (if at the sea surface) and weathers. **Chapter 4.3.1.2.2.**, Fate of Spilled Oil, details the persistence, spreading, and weathering process for offshore spills. As the slick breaks up into smaller units (e.g., slickets) and soluble components dissolve into the seawater, tarballs may remain within the water column. Tarballs may subsequently settle to the seafloor or attach to other particles or bodies in the sea. As residues of an oil spill disperse and commit to the physical environment (water, sediments, and particulates), populations or stocks of oceanic cetaceans may be exposed via the waters that they drink and swim in, as well as via the prey they consume. For example, tarballs may be consumed by fish and other marine mammal prey organisms and eventually bioaccumulate within marine mammals. Although marine mammals may (or may not) avoid oil spills or slicks, it is highly unlikely that they are capable of avoiding spill residuals in their environment. Consequently, the probability of a marine mammal being exposed to hydrocarbons resulting from a spill extends well after the oil spill has dispersed from its initial aggregated mass. Populations of marine mammals in the northern GOM would be exposed to residuals of oils spilled as a result of proposed actions over the life of the lease. In the event of a blowout, the eruption of gases and fluids may generate significant pressure waves and noise that may harass, injure, or kill marine mammals, depending on their proximity to the accident. There is 0-1 blowout projected to occur as a result of a proposed action (**Table 4-2**).

Oil spills, blowouts and spill-response activities have the potential to adversely affect cetaceans, causing physical injury and irritation, fouling of baleen plates, respiratory stress from inhalation of toxic fumes, food reduction or contamination, direct ingestion of oil and/or tar, and temporary displacement from preferred habitats or migration routes. Cetaceans do not always avoid contact with oil (e.g., Smultea and Würsig, 1995). Although an interaction with a spill could occur, primarily sublethal effects are expected due to avoidance and natural dispersion/weathering of the spill in the offshore environment. If these accidental events occur within marine mammal habitat, some potential effects follow, given that animals are exposed to pollutants. Some short-term (0-1 month) effects of oil on cetacean assemblages may be (1) changes in species or social group distributions associated with avoidance of aromatic hydrocarbons and surface oil, changes in prey distribution, and human disturbance; (2) increased mortality rates from ingestion or inhalation of oil; (3) increased petroleum compounds in tissues; and (4) impaired health (e.g., immunosuppression) (Harvey and Dahlheim, 1994). Several mechanisms for long-term injury can be postulated: (1) initial sublethal exposure to oil causing pathological damage; (2) continued exposure to hydrocarbons persisting in the environment, either directly or through ingestion of contaminated prey; and (3) altered availability of prey as a result of the spill (Ballachey et al., 1994). While no conclusive evidence of an impact on cetaceans by the *Exxon Valdez* spill was uncovered (Dahlheim and Matkin, 1994; Harvey and Dahlheim, 1994; Loughlin, 1994), evidence gathered from the studies of the *Exxon Valdez* spill indicates that oil spills have the potential to cause chronic (sublethal oil-related injuries) and acute (spill-related deaths) effects on marine mammals. The effects were particularly pronounced on fur-bearing mammals (pinnipeds and sea otters) and less clear for cetaceans. Investigations on the effects on sea otters and harbor seals revealed pathological effects on the liver, kidney, brain (also evidenced by abnormal behavior), and lungs, as well as gastric erosions (Ballachey et al., 1994; Lipscomb et al., 1994; Lowry et al., 1994; Spraker et al., 1994). In addition, harbor seal pup production and survival appeared to be affected (Frost et al., 1994). A delayed effect of oil spills on river otters was strongly suggested in Bowyer et al. (1994). Studies of sea otters in western Prince William Sound in 1996-1998 indicate continued exposure to residual *Exxon Valdez* oil (Ballachey et al., 1999; Monson et al., 2000). Oil spills have the potential to cause greater chronic (longer-term lethal or sublethal oil-related injuries) and acute (spill-related deaths occurring during a spill) effects on mammals than originally thought. A few long-term effects include (1) decreases in prey availability and abundance because of increased mortality rates; (2) change in age structure because certain year-classes were impacted more by oil; (3) decreased reproductive rate; and (4) increased rate of disease or neurological problems from exposure to oil (Harvey and Dahlheim, 1994). It has been speculated that new mortalities of killer whales may be linked to the *Exxon Valdez* spill (Matkin and Sheel, 1996). There was no evidence to directly link the Gulf War oil spill to marine mammal deaths that occurred during that time (Preen, 1991; Robineau and Fiquet, 1994). Effects of cleanup activities are unknown, but increased human presence (e.g., vessels) could add to changes in cetacean behavior and/or distribution, thereby additionally stressing animals, and perhaps making them more vulnerable to various physiologic and toxic effects.

Summary and Conclusion

Accidental blowouts, oil spills, and spill-response activities resulting from a proposed action have the potential to impact marine mammals in the GOM. Characteristics of impacts (i.e., acute vs. chronic impacts) depend on the magnitude, frequency, location, and date of accidents, characteristics of spilled oil, spill-response capabilities and timing, and various meteorological and hydrological factors. Populations of marine mammals in the northern GOM would be exposed to residuals of oils spilled as a result of a proposed action during their lifetimes. Chronic or acute exposure may result in the harassment, harm, or mortality to marine mammals occurring in the northern GOM. 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 marine mammals.

4.4.6. Impacts on Sea Turtles

Blowouts

Improperly balanced well pressures that result in sudden, uncontrolled releases of fluids from a wellhead or wellbore are called blowouts. Blowouts can occur during any phase of development: exploratory drilling, development drilling, production, completion, or workover operations. In the event of a blowout, the eruption of gases and fluids may generate significant pressure waves and noise that may harass, injure, or kill sea turtles, depending on their proximity to the accident. The effects of noise on sea turtles are discussed at length in **Chapter 4.2.1.6.**, Impacts on Sea Turtles. However, the noise attributed to a blowout is of secondary concern relative to the adverse impacts associated with underwater explosions.

Oil Spills

When an oil spill occurs, the severity of effects and the extent of damage to sea turtles are affected by geographic location; hydrocarbon type, dosage, and weathering; impact area; oceanographic and meteorological conditions; season; and life history stages of animals exposed to the hydrocarbons (NRC, 1985). All sea turtle species and life stages are vulnerable to the harmful effects of oil through direct contact or by fouling of their habitats and prey. Van Vleet and Pauly (1987) suggested that discharges of crude oil from tankers were having a significant effect on sea turtles in the Eastern GOM. Experiments on the physiologic and clinicopathologic effects of hydrocarbons have shown that major body systems of sea turtles are adversely affected by short exposure to weathered oil. Sea turtles accidentally exposed to oil or tarballs may suffer inflammatory dermatitis, ventilatory disturbance, salt gland dysfunction or failure, red blood cell disturbances, immune responses, and digestive disorders or blockages (Vargo et al., 1986; Lutz and Lutcavage, 1989; Lutcavage et al., 1995). Although disturbances may be temporary, long-term effects remain unknown, and chronically ingested oil may accumulate in organs. Direct contact with oil may harm developing turtle embryos. Exposure to hydrocarbons may be fatal, particularly to juvenile and hatchling sea turtles.

Oil can adhere to the body surface of marine turtles. Oil has been observed to cling to the nares, eyes, and upper esophagus, and to even seal the mouth (Witham, 1978; Overton et al., 1983; Van Vleet and Pauly, 1987; Gramentz, 1988; Lutcavage et al., 1995). Turtles may become entrapped by tar and oil slicks and rendered immobile (Witham, 1978; Plotkin and Amos, 1988; Gramentz, 1988). Periocular tissues and other mucous membranes would presumably be most sensitive to contact with hydrocarbons. Skin damage in turtles is in marked contrast to that observed in dolphins, where all structural and biochemical changes in the epidermis were minor and reversible. Changes in the skin are consistent with an acute, primary contact or irritant dermatitis. A break in the skin barrier could act as a portal of entry for pathogenic organisms, leading to infection, neoplastic conditions, and debilitation (Vargo et al., 1986).

Turtles surfacing in an oil spill would inhale oil vapors. Respiration of oil vapors into the lungs would probably insult and injure respiratory passages and lung tissues. Insult to lung tissues can lead to tissues weeping body fluids into the lungs, and leading to secondary drowning of the animal(s). Exposure to vapors may also reduce a sea turtle's capacity for sustained activity (aerobic scope) and its dive time, both effects decreasing the turtle's chance of escaping beyond the limits of a slick to survive. The long-term health of a turtle exposed to fumes evaporating off an oil slick may be compromised as well.

Lutcavage et al. (1995) found that operation of the salt gland in sea turtles was disrupted with exposure to hydrocarbons, but the disturbance did not appear until several days after exposure. The salt glands did recover function when tested after two weeks of recovery. Prolonged interference with salt gland functioning could have serious consequences since it would interfere with both water balance and ion regulation.

Studies on the effect of oil on digestive efficiency are underway, but Lutcavage et al. (1995) report finding oil in the feces of turtles that swallowed oil in experiments. Van Vleet and Pauly (1987) reported that oil ingested by turtles did not pass rapidly through the digestive tract but was retained within the system for a period of several days, thus increasing the likelihood that toxic components of oil could be assimilated by other internal organs and tissues of the turtle.

Significant changes in blood chemistry following contact with hydrocarbons have been reported (Lutcavage et al., 1995). Hematocrit and hemoglobin concentration decreased slightly during contact;

these parameters are critical components of the blood's oxygen transport system. The most striking hematologic finding was an elevation of white blood cell count, which may indicate a "stress" reaction related to oil exposure and/or toxicity.

Eggs, hatchlings, and small juveniles are particularly vulnerable if contacted (Fritts and McGehee, 1982; Lutz and Lutcavage, 1989). Female sea turtles crawling through tar to lay eggs can transfer the tar to the nest; this was noted on St. Vincent NWR in 1994 (USDOI, FWS and USDOC NMFS, 1997). Potential toxic impacts to embryos would depend on the type of oil and degree of weathering, type of beach substrate, and especially upon the developmental stage of the embryo. Embryonic development in an egg may be altered or arrested by contact with oil (Fritts and McGehee, 1982). Fresh oil was found to be highly toxic, especially during the last quarter of the incubation period, whereas aged oil produced no detectable effects. Fritts and McGehee (1982) concluded that oil contamination of nesting beaches would have its greatest impact on nests that were already constructed; nests made on fouled beaches are less likely to be affected, if at all. However, residual oil and tarballs may be integrated into nests by nesting females. Residues may agglutinate sand grains where eggs are deposited, later impeding hatchlings from successfully evacuating nests and ultimately leading to their death. Hatchling and small juvenile turtles are particularly vulnerable to contacting or ingesting hydrocarbons because the currents that concentrate oil spills also form the debris mats in which young turtles are sometimes found (Carr, 1980; Collard and Ogren, 1990; Witherington, 1994). This would also be true for juvenile sea turtles that are sometimes found in floating mats of sargassum. Oil slicks and tarballs moving through offshore waters may foul sargassum mats that hatchling and juvenile sea turtles inhabit, which would conceivably result in the loss of sea turtle habitat or the "take" of sea turtles. Adult sea turtles feeding selectively in surface convergence lines could experience extended exposure to viscous weathered oil (Witham, 1978; Hall et al., 1983). High rates of oil contact in very young turtles suggest that bioaccumulation may occur over their potentially long lifespan. Exposure to hydrocarbons may begin as early as eggs are deposited in contaminated beach sand. A female coming ashore to nest might be fouled with oil or transport existing residues at the driftline to the nest. During nesting, she might push oil mixed with sand into the nest and contaminate the eggs (Chan and Liew, 1988). Assuming olfaction is critical to the process, oil fouling of a nesting area might disturb imprinting of hatchling turtles or confuse the turtles on their return migration after a 6- to 8-year absence (Geraci and St. Aubin, 1985; Chan and Liew, 1988).

Some captive turtles exposed to oil either reduced the amount of time spent at the surface, possibly avoiding the oil, or became agitated and had short submergence levels (Lutcavage et al., 1995). Sea turtles pursue and swallow tarballs, and there is no firm evidence that free-ranging turtles can detect and avoid oil (Odell and MacMurray, 1986). A loggerhead turtle sighted during an aerial survey in the GOM surfaced repeatedly within a surface oil slick for over an hour (Lohoefener et al., 1989). Oil might have a more indirect effect on the behavior of marine turtles. The effect on reproductive success could therefore be significant.

Contact with hydrocarbons may not cause direct or immediate death but cumulative sublethal effects, such as salt gland disruption or liver impairment, could impair the marine turtle's ability to function effectively in the marine environment (Vargo et al., 1986; Lutz and Lutcavage, 1989). Although many observed physiological insults are resolved in a 21-day recovery period, the impact of tissue oil intake on the long-term health and survival of sea turtles remains unknown (Lutcavage et al., 1995). There is evidence of bioaccumulation in sea turtles exposed for longer periods of time. After the Gulf of Iraq war, a stranded green turtle did not appear to have contacted hydrocarbons, but upon necropsy, was found to have large amounts of oil in its liver and stomach tissues (Greenpeace, 1992).

A study of turtles collected during the *Ixtoc* spill determined that the three animals found dead had oil hydrocarbons in all tissues examined and that there was selective elimination of portions of this oil, indicating that exposure to the oil was chronic. The turtles evidently did not encounter the oil shortly before death but had been exposed to it for some time (Hall et al., 1983). The low metabolic rate of turtles may cause a limited capacity to metabolize hydrocarbons. Prolonged exposure to oil may have caused the poor body condition observed in the turtles, perhaps disrupting feeding activity. In such weakened condition, the turtles may have succumbed to some toxic component in the oil or some undiscovered agent.

The primary feeding grounds for adult Kemp's ridley turtles in the northern and southern GOM are near major areas of coastal and offshore oil exploration and production (USDOC, NMFS, 1992). The nesting beach at Rancho Nuevo, Mexico, is also vulnerable and was indeed affected by the *Ixtoc* spill.

The spill reached the nesting beach after the nesting season when adults had returned or were returning to their feeding grounds. It is unknown how adult turtles using the Bay of Campeche fared. It is possible that a high hatchling mortality occurred that year in the oceanic waters of the GOM as a result of the floating oil.

Spill-Response Activities

In addition to the impacts from contact with hydrocarbons, spill-response activities could adversely affect sea turtle habitat and cause displacement from suitable habitat to inadequate areas. Impacting factors might include artificial lighting from night operations, booms, machine and human activity, equipment on beaches and in intertidal areas, sand removal and cleaning, and changed beach landscape and composition. Some of the resulting impacts from cleanup could include interrupted or deterred nesting behavior, crushed nests, entanglement in booms, and increased mortality of hatchlings due to predation during the increased time required to reach the water (Newell, 1995; Lutcavage et al., 1997). The damage assessment and restoration plan/environmental assessment for the August 1993 Tampa Bay oil spill also noted that hatchlings that were restrained during the spill response were released on beaches other than their natal beaches, thus potentially losing them from the local nesting population (Florida Department of Environmental Protection (FDEP) et al., 1997). Additionally, turtle hatchlings and adults may become disoriented and normal behavior disrupted by human presence as well as industrial activity. Individual turtles covered with oil have been cleaned, rehabilitated, and released (e.g., FDEP et al., 1997). The strategy for cleanup operations should vary, depending on the season, recognizing that disturbance to the nest may be more detrimental than the oil (Fritts and McGehee, 1982). As mandated by OPA 90, seagrass beds and live-bottom communities are expected to receive individual consideration during spill cleanup. Required spill contingency plans include special notices to minimize adverse effects from vehicular traffic during cleanup activities and to maximize protection efforts to prevent contact of these areas with spilled oil. Loggerhead turtle nesting areas in the Chandeleur Islands, Cape Breton National Seashore, and central Gulf States would also be expected to receive special cleanup considerations under these regulations. Studies are completely lacking regarding the effects of dispersants and coagulants on sea turtles (Tucker and Associates, Inc., 1990).

Proposed Action Analysis

Since sea turtle habitat in the GOM includes inshore, neritic, and oceanic waters, as well as numerous beaches in the region, sea turtles could be impacted by accidental spills resulting from operations associated with a proposed action (one lease sale) in the EPA. The potential causes, sizes, and probabilities of oil spills that could occur during drilling, production, and transportation operations associated with a proposed action are presented in **Chapter 4.3.1.2.**, Risk Charaterization for Proposed Action Spills. **Table 4-32** lists the estimates for spill magnitude and abundance for GOM coastal waters as a result of a proposed action. Analogous estimates of spill magnitude and abundance for Federal OCS waters as a result of a proposed action are given in **Table 4-31**. However, estimates of where these accidents could occur relative to water depth are not presented. Qualitative inspection of the offshore and coastal spill data estimates shown in the tables indicates that the following would likely occur in northern GOM waters as a result of a proposed action: some, frequent, small spills; few, infrequent, moderate-sized spills; and no large spills. The assessment of spill frequency (i.e., frequent, infrequent, unlikely) is based relative to the analysis period of a proposed action.

Oil spills originating in coastal waters (as opposed to spills immigrating to coastal waters from offshore) as a result of a proposed action are assumed to encroach upon adjacent coastal lands. Spill estimates discussed in **Chapter 4.3.1.2.1.10.**, Estimated Total Volume of Oil from Assumed Spills, indicate that a proposed action may accidentally introduce approximately 13-162 bbl of oil into coastal waters over the analysis period.

Besides these coastal spills, there is a 3-4 percent and 1 percent risk an offshore spill ≥1,000 bbl occurring as a result of a proposed action and reaching coastal waters of western and eastern Louisiana, respectively, within 30 days (**Figure 4-19**). The MMS assumes that no large spills would occur in coastal waters as a result of a proposed action (**Table 4-32**). In general terms, coastal waters of the CPA are estimated to be impacted by some small spills (≤1 bbl) and few, infrequent, moderately-sized spills (>1 bbl and <50 bbl), with a low risk of being impacted by a no ≥1,000 bbl spill that occurred in offshore waters as a result of a proposed action. Pipelines pose the greatest risk of a large spill occurring in coastal waters. Plaquemines Parish, Louisiana, is the most likely landfall location where such a large spill might occur; however, this is not a turtle nesting area.

Because oil spills introduced specifically in coastal waters are assumed to impact adjacent lands, there is the potential that oil spilled in coastal waters would impact nesting beaches located proximate to likely spill locations identified in Louisiana, Mississippi, or Alabama. In Louisiana, loggerhead nesting beaches on the Chandeleur Islands are vulnerable to oil spills; however, these islands do not appear to have been used in the last several years because they suffered significant hurricane damage. Nesting loggerhead turtles utilizing the beaches of Mississippi or Alabama may be impacted by coastal spills. Recent nesting activity by Kemp's ridley turtles on Alabama beaches indicate this species may also be impacted should spills contact these beaches. Spills contacting beaches on the Gulf Coast of Florida may impact nesting green, Kemp's ridley, loggerhead, or leatherback sea turtles or their hatchlings. Spills impacting beaches of Mississippi or Alabama are not expected to impact as many nests as similar-sized spills contacting nesting beaches on the Gulf Coast of Florida. Sea turtle nesting activity is considerably greater on beaches of Texas and the Gulf Coast of Florida than those of Louisiana, Mississippi, and Alabama.

Depending on the timing of the spill's occurrence in coastal waters, its impact and resulting cleanup may interrupt sea turtle migration, feeding, mating, and/or nesting activity for extended periods (days, weeks, months). Spills originating in or migrating through coastal waters may impact any of the five sea turtle species inhabiting the GOM. Kemp's ridley is the most endangered sea turtle species and is strongly associated with coastal waters of the northern Gulf Coast. Also, green, hawksbill, loggerhead, and leatherback sea turtles use coastal waters of the northern GOM and their densities may be considerably greater during warmer months than those occurring offshore during the same period. Aside from the acute effects noted if sea turtles encounter an oil slick, the displacement of sea turtles to less suitable habitats from habitual feeding areas impacted by oil spills may increase vulnerability to predators, disease, or anthropogenic mortality. A high incidence of juvenile sea turtle foraging occurs along certain coastal regions of the Gulf Coast. The interruption of mating and nesting activities for extended periods may negatively influence future sea turtle population numbers. For example, a intermediate-sized oil spill in coastal Alabama waters could inhibit the mating or nesting activity of the Florida Panhandle subpopulation of loggerhead turtles by limiting the number of eggs being fertilized or the number of nests being constructed for one or more years, if the spill occurred during warmer months. Although no intermediate to large oil spills are assumed to occur in coastal waters of Louisiana, Mississippi, Alabama, or the Florida Panhandle region, these could act as temporary barriers to female Kemp's ridley turtles migrating along the coast to their primary nesting beach in Rancho Nuevo, Mexico. The impact to sea turtle migration corridors can be mitigated, since spill response is more feasible and timely for coastal waters than waters farther offshore.

Estimates from spill data show that Federal offshore waters would be subjected to many frequent small spills (≤1 bbl); few, infrequent, intermediate-sized spills (>1 bbl and <1,000 bbl); and/or rare, large spills (**Table 4-31**) as a result of a proposed action. The total volume of oil spilled in Federal offshore waters as a result of a proposed action is estimated at 500-700 bbl of oil. In federal waters, routine operations on platforms or drilling rigs pose the most likely source of small spills, whereas pipelines pose the most likely source of a large spill.

Neonate sea turtles undertake a passive voyage via oceanic waters after evacuating their nest. Depending on the species and population, their voyage in oceanic waters may last 10 or more years. Beaches of the Caribbean Sea and GOM are used as nesting habitat, and neonates evacuating these nesting beaches emigrate to oceanic waters seaward of their nesting sites. Surface drifter card data (Lugo-Fernandez et al., 2001) indicate that circulation patterns in the Caribbean Sea and southern GOM may transport neonate and young juvenile sea turtles from these areas to oceanic waters off the coasts of northern GOM. Moreover, these journeys begin as pulsed events, with many hatchlings emerging and emigrating offshore at the same times. Oceanic waters of the GOM are also inhabited by subadult and adult leatherback and loggerhead sea turtles; however, adults of any endemic sea turtle species may be found offshore. Consequently, intermediate to large spills occurring in these waters may impact multiple turtles, particularly neonate or young juvenile sea turtles associating with oceanic fronts or refuging in sargassum mats where oil slicks, decomposing residues, and tarballs are likely to accumulate. Large spills, particularly those flowing fresh hydrocarbons into oceanic and/or outer shelf waters for extended periods (days, weeks, months), pose an increased risk of impacting sea turtles inhabiting these waters. It is important to note that such an event may impact entire cohorts originating from nesting beaches in the Caribbean or GOM.

There is an extremely small probability that a single sea turtle would encounter an oil slick resulting from a single, small spill. Increasing the size of a slick or factoring in the number of estimated spills over 37 years increases the likelihood that an animal would encounter a single slick during the lifetime of an animal; many sea turtle species are long-live and may traverse throughout waters of the northern GOM. The web of reasoning is incomplete without considering the abundance (stock or population) of each species inhabiting the GOM. The likelihood that members of a sea turtle population (e.g., Kemp's ridley) may encounter an oil slick resulting from a single spill during a 37-year period is greater than that of a single individual encountering a slick during its lifetime. It is impractical to estimate precisely what sea turtle species, populations, or individuals would be impacted, to what magnitude, or in what numbers, because each species has unique distribution patterns in the GOM and because of difficulties attributed to estimating when and where oil spills would occur over a 37-year period.

Given the distribution of available leases and pipelines associated with a proposed action and the distribution of sea turtles in the northern GOM, the fate of an oil spill must be considered relative to the region and period of exposure. Spill estimates derived from data documenting historical trends of oil spills in coastal and offshore waters indicate that a proposed action in the EPA may introduce 513-862 bbl (coastal plus offshore spill volumes) of oil into GOM offshore and coastal environments over 37 years. Spills of any size degrade water quality, and residuals become available for bioaccumulation within the food chain. Slicks may spread at the sea surface or may move underwater from the seafloor through the water column some distance away from the spill source. Regardless, a slick is a dynamic, but aggregated mass of oil that, with time, would disperse into smaller units as it evaporates (if at the sea surface) and weathers. **Chapter 4.3.1.2.2.**, Fate of Spilled Oil, details the persistence, spreading, and weathering process for offshore spills. As the slick breaks up into smaller units (e.g., slickets) and soluble components dissolve into the seawater, tarballs may remain within the water column. Tarballs may subsequently settle to the seafloor or attach to other particles or bodies in the sea. As residues of an oil spill disperse and commit to the physical environment (water, sediments, and particulates), sea turtles of any life history stage may be exposed via the waters that they drink and swim, as well as via the prey they consume. For example, tarballs may be consumed by sea turtles and by other marine organisms, and eventually bioaccumulate within sea turtles. Although sea turtles may (or may not) avoid oil spills or slicks, it is most unlikely that they are capable of avoiding spill residuals in their environment. Consequently, the probability that a sea turtle is exposed to oil resulting from a spill extends well after the oil spill has dispersed from its initial aggregated mass. Populations of sea turtles in the northern GOM would be exposed to residuals of oils spilled as a result of a proposed action during their lifetimes.

In general, on a yearly basis, about 1 percent of strandings identified by the U.S. Sea Turtle Stranding Network are associated with oil (e.g., Teas and Martinez, 1992). Turtles do not always avoid contact with oil (e.g., Lohoefener et al., 1989). Contact with petroleum and consumption of oil and oil-contaminated prey may seriously impact turtles; there is direct evidence that turtles have been seriously harmed by petroleum spills. Oil spills and residues have the potential to cause chronic (long-term lethal or sublethal oil-related injuries) and acute (immediate spill-related deaths attributable to a spill) effects on turtles. Several mechanisms for long-term injury can be postulated: sublethal initial exposure to oil-causing pathological damage; continued exposure to hydrocarbons persisting in the environment, either directly or through ingestion of contaminated prey; and altered prey availability as a result of the spill.

Due to spill response and cleanup efforts, much of an oil spill may be recovered before it reaches the coast. However, cleanup efforts in coastal or offshore waters may result in additional harm or mortality of sea turtles, particularly to neonates and juveniles. Oil spills and spill-response activities at nesting beaches, such as beach sand removal and compaction, can adversely impact sea turtles. Although spill-response activities such as vehicular and vessel traffic during nesting season are assumed to affect sea turtle habitats, additional harm may be limited because of efforts designed to prevent spilled oil from contacting these areas, as mandated by OPA 90. Increased human presence could influence turtle behavior and/or distribution, thereby stressing animals and making them more vulnerable to predators, the toxicological effects of oil, or other anthropogenic sources of mortality.

In the event of a blowout, the eruption of gases and fluids may generate significant shock waves and noise that may harass, injure, or kill sea turtles, depending on their proximity to the accident. There may be one blowout as a result of a proposed action (**Table 4-2**).

Summary and Conclusion

Accidental blowouts, oil spills, and spill-response activities resulting from a proposed action have the potential to impact small to large numbers of sea turtles in the GOM, depending on the magnitude and frequency of accidents, the ability to respond to accidents, the location and timing of accidents, and various meteorological and hydrological factors. Populations of sea turtles in the northern GOM would be exposed to residuals of oils spilled as a result of a proposed action during their lifetimes. Chronic or acute exposure may result in the harassment, harm, or mortality to sea turtles occurring in the northern GOM. 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. Sea turtles hatchlings exposed to and becoming fouled by or consuming tarballs persisting in the sea following the dispersal of an oil slick would likely result in their death.

4.4.7. Impacts on the Alabama, Choctawhatchee, St. Andrews, and Perdido Key Beach Mice, and the Florida Salt Marsh Vole

Coastal spills are assumed to occur, due to accidents from proposed action operations, near pipeline terminals (Louisiana, near Timbalier Bay, Grand Isle, or east of the Mississippi River) or the primary service bases (Venice and Fourchon, Louisiana and Mobile, Alabama). Of the likely locations of coastal spills, Mobile, Alabama is the closest to beach mice. The MMS estimates a total of 12 to 16 spills in GOM coastal waters are likely to occur as a result of a proposed action; 10 to 12 of these spills would be ≤1 bbl; and 3 of these would be >1 bbl and <50 bbl. No spills larger than 50 bbl are assumed to occur in coastal waters as a result of support activities. Spill slicks would be restricted in size and rapidly cleaned up. No endangered beach mice would be affected were a small coastal spill to occur.

For a spill from a proposed action to persist long enough to reach beach mice habitat (**Figure 4-25**), the volume spilled would have to be ≥1,000 bbl (**Chapter 4.3.1.2.3.3.**, Likelihood of an Offshore Spill Occurring and Contacting Modeled Locations of Environemntal Resources). Modeling results show that the probability of an oil spill ≥1,000 bbl occurring from a proposed action and contacting endangered beach mouse habitat within 10 or 30 days is <0.5 percent. The probability of a spill occurring and contacting the shoreline of Levy County, the location of the only population of the Florida salt marsh vole, as a result of a proposed action is <0.5 percent.

Direct contact with spilled oil can cause skin and eye irritation to endangered beach mice. Other direct toxic effects include asphyxiation from inhalation of fumes, oil ingestion, and food contamination. Indirect impacts from oil spills, should they reach habitat areas, would include reduction of food supply, destruction of habitat, and fouling of nests. Impacts can also occur from spill-response activities. Vehicular traffic and other activities associated with oil-spill cleanup can degrade preferred habitat and cause displacement of mice from these areas.

The ranges of the four endangered subspecies of beach mice are shown in **Figure 4-25**.

There is no definitive information on the persistence of beached oil in the event a spill was to contact beach mouse habitat. In Prince William Sound, Alaska, as a result of the *Exxon Valdez* spill in 1989, buried oil is still found in the intertidal zone of beaches, but no effort has been made to search for residual buried oil above high tide. Similarly, NRC (1985) makes no mention of studies of oil left above high tide after a spill. Regardless of the potential persistence of stranded oil in beach mouse habitat, a slick cannot wash above high tide, over the foredunes, and into the preferred habitat of the endangered beach mice unless the oil is carried by a heavy storm swell.

Summary and Conclusion

Given the necessity of coincident storm surge for oil to reach beach mouse or vole habitat, and contact the beach mice or vole, no direct impacts of oil spills on beach mice from a proposed action are anticipated. Protective measures required under the Endangered Species Act should prevent any oil-spill response and clean-up activities from having significant impact to the beach mice and vole, and their habitat.

4.4.8. Impacts on Coastal and Marine Birds

Oil Spills

In general, oil spills pose the greatest potential impact to coastal and marine birds. Coastal spills are assumed to occur, from accidents associated with proposed action operations, near pipeline terminals (Louisiana, near Timbalier Bay, Grand Isle, or east of the Mississippi River) or the primary service bases (Venice and Fourchon, Louisiana and in Mobile, Alabama). The MMS estimates a total of 12 to 16 spills into GOM coastal waters as a result of a proposed action; 10 to 12 of these spills would be ≤1 bbl; and 3 of these would be >1 bbl and <50 bbl. No spills larger than 50 bbl are estimated to occur in coastal waters as a result of support activities. Spill slicks would be restricted in size and rapidly cleaned up. A small number of any of several taxa of coastal birds could be affected were a small coastal spill to occur. Small coastal spills would affect many of the different groups of coastal and marine birds, most commonly marsh birds, waders, waterfowl, and certain shorebirds.

We assume that 220 to 290 offshore spills ≤1 bbl; 50 to 60 spills >1 bbl and <10 bbl; and 1 spill between 10 and 50 bbls would occur offshore over the life of a proposed action. There is a 9-12 percent chance of one or more spill ≥1,000 bbl occurring as a result of a proposed action, a 3-4 percent chance for spills between 500 and 1,000 bbl, a 34-42 percent chance for spills between 50 and 500 bbl, and a 65-75 percent chance for the occurrence of a spill between 10 and 50 bbl. For spills <10 bbl, there is a 99 percent that there would be a spill of this size sometime during the life of a proposed action. Of these, OSRA modeling data are provided for spills ≥1,000 bbl, for which risk to separate bird resources are discussed below and shown in **Figures 4-26 through 4-36**.

Pneumonia is not uncommon if birds are oiled birds and can occur when birds, attempting to clean their feathers through preening, inhale droplets of oil. Exposure to oil can cause severe and fatal kidney damage (reviewed by Frink, 1994). Ingestion of oils might reduce the function of the immune system and, thus, reduce resistance to infectious diseases (Leighton, 1990). Ingested oil may cause toxic destruction of red blood cells and varying degrees of anemia (Leighton, 1990). Stress and shock enhance the effects of exposure and poisoning. The pathological conditions noted in autopsies may be directly caused by petroleum hydrocarbons or may be a final effect in a chain of events with oil as the initial cause and generalized stress as an intermediate cause (Clark, 1984). Low levels of oil could stress birds by interfering with food detection, feeding impulses, predator avoidance, territory definition, homing of migratory species, susceptibility to physiological disorders, disease resistance, growth rates, reproduction, and respiration.

In conclusion, if physical oiling of individuals or local groups of birds were to occur, some degree of both acute and chronic physiological stress associated with direct and secondary uptake of oil would be expected. Some deaths from these groups are to be expected. Diving birds occur continuously with few breaks on the Gulf Coast. The probability of an oil spill ≥1,000 bbl occurring from a proposed action and contacting diving bird habitat is 1 percent within 10 days and 2-3 percent after 30 days. Some of the birds most susceptible to population-level impact of an oil spill are those that sit on the water and then dive rather than fly when disturbed. Raptors are distributed continuously over the Gulf Coast except for the shores of Louisiana. The probability of an oil spill ≥1,000 bbl occurring from a proposed action and contacting raptor habitat is <0.5 percent within 10 days and 1 percent within 30 days. Bald eagle habitat is more continuous along the coast from Louisiana to Florida. The probability for contact of bald eagle habitat is 2 percent within 10 days and 3-10 percent within 30 days. The bald eagle and peregrine falcon feed upon weakened or dead birds (and fish, in the case of the eagle) and as a result may become physically oiled or affected by the ingestion of the oiled prey. Brown pelicans are distributed widely from Texas to Florida, with large reaches of shorelines uninhabited. The probability of an oil spill ≥1,000 bbl occurring from a proposed action and contacting brown pelican habitat is 1 percent within 10 days and 2 percent within 30 days. Brown pelicans are active swimmers and plunge dive for prey. They are therefore susceptible to both physical oiling and secondary effects via ingestion of oiled prey (i.e., fish). Snowy plover are distributed from Texas to Florida, and distribution alternates between long reaches of inhabited shoreline and long stretches of uninhabited shore. The probability of an oil spill ≥1,000 bbl occurring from a proposed action and contacting snowy plover habitat is 1 percent within 10 days and 2 percent within 30 days. On wintering grounds, piping plover is distributed almost continuously from Texas to Florida. Contact with piping plover habitat it is 2 percent within 10 days and 3-4 percent within

30 days. Plovers congregate and feed along tidally exposed banks and shorelines, following the tide out and foraging at the water's edge. They have short stout bills and chase mobile prey rather than probing into the sediment with long slender bills like many birds of the sandpiper family. If a shoreline is oiled, plovers can physically oil themselves while foraging on oiled shores or secondarily contaminate themselves through ingestion of oiled intertidal sediments and prey. If an offshore spill were to occur and reach the coast, oil would reach the intertidal beach feeding areas before it would contact nests on the fore dunes. Gulls, terns, and charadriid allies, as a group, are mostly distributed continuously form Texas to Florida. The probability of an oil spill ≥1,000 bbl occurring from a proposed action and contacting habitat of gulls, terns, and charadriid allies is 2 percent within 10 days and 3-4 percent within 30 days. The least tern captures fish by means of shallow splash diving and surface dipping techniques. Some physical oiling could occur during these dives, as well as secondary toxic effects through the uptake of prey.

Wading birds are distributed almost continuously from Texas to Florida, except for the western coast of Louisiana. It is possible that some death of endangered/threatened (as well as nonendangered and nonthreatened) species could occur, especially if a spill were to occur during winter months when raptors and plovers are most common along the coastal GOM or if spills contact preferred or critical habitat. Should oiling occur, recruitment through successful reproduction is expected to take one or more annual breeding cycle, depending upon the species and existing conditions.

The probability of an oil spill ≥1,000 bbl occurring from a proposed action and contacting wading bird habitat is 1-2 percent within 10 days and 2-3 percent within 30 days. Direct oiling of wading birds, including some long-legged shorebirds, is usually minor because they would only be contaminated by a slick on the sea surface, which may contact the birds' legs, necks, bills, and heads, but little else, when they are feeding through the slick. Many of these birds are merely stained as a result of their foraging behaviors (Vermeer and Vermeer, 1975). Birds can ingest oil when feeding on contaminated food items or drinking contaminated water. Oil contamination would affect prey upon which birds depend. Prey populations after the *Arthur Kill* spill (January 1990, south coast of New York) had not returned to normal a year after the spill.

Waterfowl are distributed continuously along the Gulf Coast from Texas to Florida. The probability of an oil spill ≥1,000 bbl occurring from a proposed action and waterfowl habitat is 2-3 percent within 10 days and 4-5 percent within 30 days. Geese and herbivorous ducks feed at a lower trophic level than the other species of waterbirds and may not suffer damaging effects when oil is biomagnified, or at least not to the same degree (Maccarone and Brzorad, 1994). They still may encounter lower food availability, owing to the localized destruction of aquatic vegetation. Birds, such as ibises, that sift through mud and other sediments for small invertebrates may be exposed to high toxin levels in the invertebrates (Maccarone and Brzorad, 1994). Chapman (1981) noted that oil on the beach from the 1979 *Ixtoc* spill caused habitat shifts by the birds. Many birds had to feed in less productive feeding habitats. Similar observations were made for wading birds after the *Arthur Kill* spill (Maccarone and Brzorad, 1995). Composition of prey populations changed after the spill. Shoreline vegetation may die after prolonged exposure to water contaminated with oil. Lush vegetation helps to conceal sparsely placed nests and their contents from potential predators. With destruction of vegetation, aerial predators may have easier access to eggs and chicks (Maccarone and Brzorad, 1994). Many species have inherently low reproductive potential, slowing recovery from impacts.

A population that endures oil-spill impacts may have the disadvantage of a long-flying distance to habitat of neighboring colonies. Otherwise, neighboring colonies' habitat could provide refuge for a bird population fleeing impacts and be a source of recruitment to a population recovering from impacts (Cairns and Elliot, 1987; Trivelpiece et al., 1986; Samuels and Ladino, 1983/1984). In that case, population recovery following destruction of a local breeding colony or a large group of wintering migrants would likely occur within 1-2 yearly breeding cycles. For many coastal and marine species, spills may delay the maturation and reproduction process in juveniles, and this could cause a decrease in reproductive success for at least one season (Butler et al., 1988). Disruption of pair bonds and altered cycles of reproductive hormones might also affect reproductive success for one breeding season (Leighton, 1990).

Oil-Spill Response and Cleanup Activities

Oil-spill cleanup methods often require heavy trafficking of beaches and wetland areas, application of oil dispersants and bioremediation chemicals, and the distribution and collection of oil containment booms and absorbent material. The presence of humans, along with boats, aircraft, and other technological creations, would also disturb coastal birds after a spill. Investigations have shown that oil-dispersant mixtures pose a threat like that of oil to successful reproduction in birds (Albers, 1979; Albers and Gay, 1982). The external exposure of adult birds to oil/dispersant emulsions may reduce chick survival more than exposure to oil alone would; however, successful dispersal of a spill would generally reduce the probability of exposure of coastal and marine birds to oil (Butler et al., 1988). It is possible that changes in size of an established breeding population may also be a result of disturbance in the form of personnel for shoreline cleanup, monitoring efforts, or the intensified research activity after oil spills (Maccarone and Brzorad, 1994). Studies are indicating that rescue and cleaning of oiled birds makes no effective contribution to conservation, except conceivably for species with a small world population (Clark, 1978 and 1984). A growing number of studies indicate that current rehabilitation techniques are not effective in returning healthy birds to the wild (Anderson et al., 1996; Boersma, 1995; Sharp, 1995 and 1996). Preventative methods, such as scaring birds from the path of an approaching oil slick or the use of booms to protect sensitive colonies in an emergency, are also not effective (Clark, 1984).

Summary and Conclusion

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

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

Figures 4-27, 4-29, and 4-30 show the probability of offshore spills (≥1,000 bbl) occurring and contacting wintering piping plovers, brown pelicans, and bald eagles within 10 or 30 days as a result of a proposed action. While foraging on oiled shores, piping plovers can physically oil themselves or secondarily contaminate themselves through ingestion of oiled intertidal sediments and prey. If an offshore spill were to occur and reach the coast, oil would reach the intertidal beach feeding areas before it would contact piping plover nests on the fore dunes. Brown pelicans are susceptible to both physical oiling and secondary effects via ingestion of oiled prey (i.e., fish). Bald eagles may become physically oiled or affected by the ingestion of the oiled prey.

4.4.9. Impacts on Endangered and Threatened Fish

4.4.9.1. Gulf Sturgeon

Oil spills pose the greatest potential impact to Gulf sturgeon. Few small coastal spills are estimated to occur, as a result of proposed action support operations, east of the Mississippi River and near Mobile, Alabama. No spills larger than 50 bbl are estimated to occur in coastal waters as a result of support activities. Spill slicks would be restricted in size and rapidly cleaned up. A small number of Gulf sturgeons could be affected were a small coastal spill to occur.

We assume that 220-290 offshore spills ≤1 bbl; 50-60 spills >1 bbl and <10 bbl; and 1 spill between 10 and 50 bbl would occur offshore over the life of a proposed action. There is a 9-12 percent chance of one or more spills ≥1,000 bbl occurring as a result of a proposed action, a 3-4 percent chance for spills between 500 and 1,000 bbl, a 34-42 percent chance for spills between 50 and 500 bbl, and a 65-75 percent chance for the occurrence of a spill between 10 and 50 bbl. For spills less than 10 bbl, there is a 99 percent that there would be a spill of this size sometime during the life of a proposed action. Only spills of 50 bbl or more could reach shore before dissipating. Risk to Gulf sturgeon is shown in **Figure 4-23**. The probability of an oil spill ≥1,000 bbl occurring from a proposed action and contacting Gulf sturgeon habitat is 1 percent within 10 days and 2 percent within 30 days.

Existing occurrences of Gulf sturgeon in 1996 extended from the Mississippi River to Charlotte Harbor in western Florida (Patrick, personal communication, 1996). Oil spills are the OCS-related factor most likely to impact the Gulf sturgeon. Oil can affect Gulf sturgeon by direct ingestion or ingestion of oiled prey or by the absorption of dissolved petroleum products through the gills. Upon any exposure to spilled oil, liver enzymes of adult fish oxidize soluble hydrocarbons into compounds that are easily excreted in the urine (Spies et al., 1982). Contact with or ingestion/absorption of spilled oil by adult Gulf sturgeon could result in mortality or nonfatal physiological impact, especially irritation of gill epithelium and disturbance of liver function. Behavior studies of other fish species suggest that adult sturgeon are likely to actively avoid an oil spill, thereby limiting the effects and lessening the extent of damage (Baker et al., 1991; Malins et al., 1982).

Chapter 4.3.1.2., Risk Charaterization for Proposed Action Spills, discusses the risk of oil spills estimated as a result of a proposed action. Also discussed is the probability of occurrence and contact between a proposed-action-related spill and the coastal area known to be inhabited by the Gulf sturgeon. This analysis concluded that there is a very low risk of spills reaching coastal waters inhabited by Gulf sturgeon, and few if any adult Gulf sturgeons are assumed to be impacted by these spills.

Summary and Conclusion

The Gulf sturgeon could be impacted by oil spills resulting from a proposed action. Contact with spilled oil could cause irritation of gill epithelium and disturbance of liver function in Gulf sturgeon. The likelihood of spill occurrence and contact to the Gulf sturgeon as a result of a proposed action is very low, 1 percent within 10 days and 2 percent within 30 days.

4.4.9.2. Smalltooth Sawfish

Potential impacts to the smalltooth sawfish from a proposed action could occur from accidental oil spills. Oil could affect smalltooth sawfish by direct ingestion or ingestion of oiled prey or by the absorption of dissolved petroleum products through the gills. Contact with or ingestion/absorption of spilled oil by smalltooth sawfish could result in mortality or nonfatal physiological impact, especially irritation of gill epithelium and disturbance of liver function.

The numbers and sizes of oil spills estimated to occur as a result of a proposed action are provided in **Chapter 4.3.1.2.**, Risk Charaterization for Proposed Action Spills. It is assumed that 220-290 offshore spills ≤1 bbl, 50-60 spills >1 bbl and <10 bbl, and 1 spill between 10 and 50 bbl would occur offshore over the life of a proposed action. There is a 9-12 percent chance for one or more spills ≥1,000 bbl occurring as a result of a proposed action, a 3-4 percent chance for spills between 500 and 1,000 bbl, a 34-42 percent chance for spills between 50 and 500 bbl, and a 65-75 percent chance for the occurrence of a spill between 10 and 50 bbl. There is a 99 percent chance that there would be a spill <10 bbl sometime during the life of a proposed action. Only spills of ≥50 bbl could reach shore before dissipating. The current population of smalltooth sawfish is primarily found in southern Florida in the Everglades and Florida Keys. The probability of an oil spill ≥1,000 bbl occurring from a proposed action and contacting these areas is <0.5 percent within both 10 and 30 days (**Figures 4-19 and 4-20**).

Summary and Conclusion

Potential impacts to the smalltooth sawfish from a proposed action could occur from accidental oil spills. Contact with or ingestion/absorption of spilled oil by smalltooth sawfish could result in mortality or nonfatal physiological impact, especially irritation of gill epithelium and disturbance of liver function. However, because the current population of smalltooth sawfish is primarily found in southern Florida in the Everglades and Florida Keys, and the low probability of these areas being contacted by an oil spill, impacts to these rare animals from accidental events associated with a proposed action are unlikely.

4.4.10. Impacts on Fish Resources, Essential Fish Habitat, and Commercial Fishing

Accidental events that could impact fish resources, EFH, and commercial fisheries include blowouts and oil or chemical spills. Due to the close association between discussions and proposed action analyses, the previously separate treatment of commercial fisheries has been combined in this single section. Impacts from other than accidental sources are discussed in **Chapter 4.2.1.10.** for fish resources and EFH and in **Chapter 4.2.1.11.** for commercial fishing.

Blowouts

Subsurface blowouts have the potential to adversely affect fish resources and commercial fishing. A blowout at the seafloor could create a crater, and resuspend and disburse large quantities of bottom sediments within a 300-m radius from the blowout site, potentially affecting a limited number of fish in the immediate area. A blowout event, though highly unlikely, could cause damage to the nearby bottom and render the affected area closed to bottom fisheries, although no bottom commercial fisheries exist in the proposed lease sale area where water depths exceed 1,600 m. The majority of mobile deep-sea benthic or near-bottom fish taxa would be expected to leave (and not reenter) the area of a blowout before being impacted by the localized area of resuspended sediments.

Resuspended sediments may clog gill epithelia of finfish with resultant smothering. Settlement of resuspended sediments may directly smother deep-water invertebrates. However, coarse sediment should be redeposited within several hundred meters of a blowout site. Finer sediments can be more widely dispersed and redeposited over a period of hours to days within a few thousand meters depending on the particle size. Oil loss from a blowout is rare. Less than 10 percent of blowouts in recent history have resulted in spilled oil. Gas blowouts are less of an environmental risk, resulting in resuspended sediments and increased levels of natural gas for a few days very near the source of the blowout. Loss of gas-well control does not release liquid hydrocarbons into the water. Natural gas consists mainly of methane, which rapidly disperses upward into the air (Van Buuren, 1984).

Spills

The risk of oil spills from a proposed action is discussed in detail in **Chapter 4.3.1.2.**, Risk Charaterization for Proposed Action Spills; their characteristics, sizes, frequency, and fate are summarized in this chapter. Spills that may occur as a result of a proposed action have the potential to affect fish resources, EFH, and commercial fishing in the GOM. The toxicity of an oil spill depends on the concentration of the hydrocarbon components exposed to the organisms (in this case fish) and the variation of the sensitivity of the species considered. The geographic range of the pollutant effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource to the pollutant in question. In this case, hydrocarbons are the primary pollutants of concern. The effects on and the extent of damage to fisheries resources and GOM commercial fisheries from a petroleum spill are restricted by time and location. The impacts discussed in this EIS can be estimated from examinations of recent spills such as the *North Cape* (Rhode Island, 1996), Breton Point (*Vessel World Prodigy*, Rhode Island, 1989), *Sea Empress* (United Kingdom, 1996), and *Exxon Valdez* (Alaska, 1989) (Brannon et al., 1995; Maki et al., 1995; Mooney, 1996; Pearson et al., 1995). The amount of oil spilled by each event and its estimated impact to fishing practices, fish resources, and fisheries economics can be used as a guideline to estimate the impacts on fisheries.

The direct effects of spilled petroleum on fish occur through the ingestion of hydrocarbons or contaminated prey, through the uptake of dissolved petroleum products through the gills and epithelium by adults and juveniles, and through the death of eggs and decreased survival of larvae (NRC, 1985). Adult fish must experience continual exposure to relatively high levels of hydrocarbons over several months before secondary toxicological compounds that represent biological harm are detected in the liver (Payne et al., 1988). Upon exposure to spilled petroleum, liver enzymes of fish oxidize soluble hydrocarbons into compounds that are easily excreted in the urine (Spies et al., 1982). Ordinary environmental stresses may increase the sensitivity of fish to petroleum toxicity. These stresses may include changes in salinity, temperature, and food abundance (Evans and Rice, 1974; NRC, 1985).

When contacted by spilled hydrocarbon, floating eggs and larvae, with their limited mobility and physiology, and most juvenile fish are killed (Linden et al., 1979; Longwell, 1977). Large numbers of fish eggs and larvae have been killed by oil spills. Sublethal effects on larvae, including genotoxic damage have been documented from sites oiled from the *Exxon Valdez* (DeMarty et al., 1997). Hose and Brown (1998) also detected genetic damage in Pacific herring from sites within the oil trajectory of the *Exxon Valdez* spill two months after the spill with decreasing rates of genotoxicity for two additional months after the spill. No detectable genotoxicity was detectable from sampling conducted two years following the spill. Mortality rates for pink salmon embryos were found to be significantly higher than controls at exposure levels of 1 ppb total PAH concentration (Heintz, 1999).

Fish over-produce eggs on an enormous scale and the overwhelming majority of them die at an early stage, generally as food for predators. Even a heavy death toll of eggs and larvae from an oil spill may have no detectable effect on the adult populations exploited by commercial fisheries. This has been confirmed during and after the *Torrey Canyon* spill off southwest England and the *Argo Merchant* spill off Nantucket. In both cases, a 90 percent death of fish eggs and larvae of pilchard and pollack, respectively, was observed in the affected area, but this had no impact on the regional commercial fishery (Baker et al., 1991).

Adult fish are likely to actively avoid a spill, thereby limiting the effects and lessening the extent of damage (Baker et al., 1991; Malins et al., 1982; Maki et al., 1995). Observations at oil spills around the world, including the *Exxon Valdez* spill in Prince William Sound, consistently indicate that free-swimming fish are rarely at risk from oil spills (Lancaster et al., 1999; Squire, 1992). Fish swim away from spilled oil, and this behavior explains why there has never been a commercially important fish-kill on record following an oil spill. Modeling of impacts for the *North Cape* spill is an exception (French, 1998). The impact modeling for this heating oil spill off Rhode Island in 1996 included theoretical moralities of adult fish, but the model does not consider any avoidance of the spill area and mortality estimates were based on normal populations found in the area from previous trawling databases. The *North Cape* spill was also unusual due to conditions that caused heavy entrainment of pollutants from large-wave turbulence, and hydrocarbons were retained in shallow water for many days due to tidal currents. Some recent work has demonstrated avoidance of extremely small concentrations of hydrocarbons. Farr et al. (1995) reported the behavioral avoidance of dissolved concentrations of a PAH as low as 14.7 μg/l by a species of minnow.

The only substantial adult fish-kill on record following an oil spill was on the French coast when several tons of small rock-clinging fish (not commercially harvested) were killed at the site of the *Amoco Cadiz* wreck. In addition, some concerns about the impact of spilled oil on the breeding cycle of commercial fishery resources have proved to be unfounded (Baker et al., 1991). Some recent work has reported potential sublethal impacts including the expression of subclinical viral infection correlated to experimental exposure of adult Pacific herring exposed to weathered crude oil (Carls et al., 1998).

Spills that contact coastal bays, estuaries, and waters of the OCS when pelagic eggs and larvae are present have the greatest potential to affect commercial fishery resources. For eggs and larvae contacted by a spill, the effect is expected to be lethal. Migratory species, such as mackerel, cobia, and crevalle, could be impacted if a spill contacts nearshore open waters. A spill contacting a low-energy inshore area would affect localized populations of commercial fishery resources, such as menhaden, shrimp, and blue crabs. The nearshore fishery was closed for approximately nine weeks in the case of the *North Cape* spill where dispersal of spilled oil away from shallow water was very slow. Long-term leaching of PAH's from the *Exxon Valdez* spill into Prince William Sound has been observed to cause some impacts to local fish populations, but low temperature and other conditions of Alaska shorelines do not apply to the GOM. Chronic petroleum contamination in an inshore area would affect all life stages of a localized population of a sessile fishery resource such as oysters. Nonmotile shellfish (e.g., oysters) would not be able to avoid a spill but could shut down filtering for some period of time, depending on the water temperature and other environmental conditions.

For OCS-related spills to have an effect on an offshore commercial fishery resource, whether estuary dependent or not, eggs and larvae would have to be abnormally concentrated in the immediate spill area (Pearson et al., 1995). Hydrocarbon components also would have to be present in highly toxic concentrations when both eggs and larvae are in the pelagic stage (Longwell, 1977). Pearson et al. (1999)

analyzed hypotheses of why the Pacific herring fisheries in Prince William Sound collapsed in 1993 and 1994, three years after the *Exxon Valdez* oil spill. A number of factors analyzed indicated that the 1989 oil spill did not contribute to the 1993 decline, including the record high levels of harvests of Prince William Sound herring in the years immediately following the oil spill, the lack of change from the expected age-class distribution, and the low level of oil exposure documented for the herring in 1989. Some reports indicate the impact of exposure of fish fry is limited. Birtwell et al. (1999) reported that exposure of populations of pink salmon fry to the aromatic hydrocarbon, water-soluble fraction of crude oil for 10 days and released to the Pacific Ocean did not result in a detectable effect on their survivability to maturity. There is no evidence at this time that commercial fisheries in the GOM have been adversely affected on a regional population level by spills or chronic contamination.

Development abnormalities in juveniles occur naturally in wild fish populations, and the frequency of these abnormalities is increased in populations chronically exposed to petroleum. These abnormal fish do not survive long. Such delayed death is likely to have a negligible impact on commercial fisheries, as are the immediate deaths following a petroleum spill (Pearson et al., 1995).

If chemical spills occur, they would likely occur at the surface and most would rapidly dilute, affecting a small number of fish in a highly localized environment. Many of the chemical products that may be used offshore, such as methanol or hydrochloric acid, would chemically burn all exposed surfaces of fish that come in contact. The concentration of the chemical and the duration of exposure determines the extent of the chemical burn. Rapid dilution in seawater would limit the effects, and the impacts should be inconsequential. Other compounds such as zinc bromide would not readily dilute in seawater and would likely form slowly dissolving piles on the seafloor. Although these compounds may be toxic, mobile fishes would avoid them as they do oil spills. Nonmotile fish and slow-moving invertebrates could be killed. The areal extent of the impacts would be highly localized and the impacts should be inconsequential.

Proposed Action Analysis

Healthy fishery stocks depend on EFH waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Due to the wide variation of habitat requirements for all life history stages (as described in **Chapter 3.2.8.**, Fisheries) for species in a proposed action area, EFH for the GOM includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the EEZ. The effect of accidental events from a proposed action on coastal wetlands and coastal water quality is analyzed in **Chapters 4.4.3.2. and 4.4.2.1.**, respectively.

The potential causes and probabilities of blowouts are discussed in **Chapter 4.3.2.** A blowout with hydrocarbon release has a low probability of occurring as a result of a proposed action. Only 0-1 blowout is expected for the entire depth range of a proposed action area. The single blowout that could occur in a proposed action area would cause limited impacts to localized areas. Given the low probability that a large blowout would occur and the deepwater environment, blowouts are not expected to significantly affect future water quality (EFH). A gas blowout would have a temporary and minimal effect on the water column (EFH) as virtually all the gas would rise rapidly to the surface and enter the atmosphere.

Risk of Offshore Spills

The potential causes, sizes, and probabilities of petroleum spills estimated to occur during activities associated with a proposed action are discussed in **Chapter 4.3.1.2.1.**, Frequency, Magnitude, and Source of Spilled Oil from a Proposed Action, and are listed in **Table 4-31** for offshore spills and **Table 4-32** for coastal spills. Information on spill response and cleanup is contained in **Chapter 4.3.1.1.5.**, Spill-Response Capabilities. A number of spill scenarios are analyzed in **Chapter 4.3.1.2.2.**, Fate of Spilled Oil. The most likely spill ≥1,000 bbl estimated to occur as a result of a proposed action is a pipeline break. Persistence of oil in the environment depends on a variety of factors. It is estimated that slicks from spills <1,000 bbl would persist a few minutes (<1 bbl), a few hours (<10 bbl), or a few days (10-1,000 bbl) on the open ocean. Spilled oil would rapidly spread out, evaporate, and weather, quickly becoming dispersed into the water column. Based on past OCS spill records, most spills <1,000 bbl are estimated to be diesel, which dissipates very rapidly.

The probabilities that various size offshore spills occurring over the life of a proposed action are listed in **Table 4-33**. The most likely number of offshore spills ≥1,000 bbl that are predicted to occur is zero. The probability that one or more spills ≥1,000 bbl would occur ranges from 9 to 12 percent (**Table 4-31**). Probability of occurrence and contact with specific offshore areas are included in **Table 4-34**.

The most likely source or cause of an offshore spill is also discussed in **Chapter 4.3.1.2.1.6.** The most frequently spilled oil has been diesel used to operate the facilities, not the crude being produced. The most likely size of spill is the smallest size group, <1 bbl. Spills that contact coastal bays and estuaries in Texas or Louisiana would have the greatest potential to affect fish resources. Two parishes have a likelihood (>0.5%) that an offshore spill ≥1,000 bbl would occur as a result of a proposed action and contact their shorelines: Lafourche Parish with a probability of 0.5-1 percent and Plaquemines Parish with a probability of 1-2 percent. The risk of an offshore spill ≥1,000 bbl occurring, and contacting the Flower Garden Banks or the FMG, EFH Habitat Areas of Particular Concern (HAPC), is less than <0.5 percent. The biological resources of other hard/live bottoms in the GOM (EFH) would remain unharmed as spilled substances could, at the most, reach the seafloor in minute concentrations considering the great distances and time required for transportation from the deepwater areas of a proposed action.

Risk from Coastal Spills

A total of 12-16 spills of all sizes are estimated to occur within Louisiana coastal waters from an accident associated with support operations for a proposed action. Most all of these (10-12) are assumed to be <1 bbl in size (**Table 4-32**). Coastal spills are assumed to occur near pipeline terminals or the major service bases and to affect a highly localized area with low-level impacts. Due to spill response and cleanup efforts, most of the inland spill would be recovered and what is not recovered would affect a very small area and dissipate rapidly. It is also assumed that a petroleum spill would occasionally contact and affect nearshore and coastal areas of migratory GOM fisheries. These species are highly migratory and would actively avoid the spill area.

The effect of petroleum spills on fish resources as a result of a proposed action is expected to cause less than a 1 percent decrease in fish resources or standing stocks of any population. At the expected level of impact, the resultant influence on fish populations within or in the general vicinity of the proposed lease sale area would be negligible and indistinguishable from natural population variations.

Commercial fishermen would actively avoid the area of a blowout or spill. Even if fish resources successfully avoid spills, tainting (oily-tasting fish), public perception of tainting, or the potential of tainting commercial catches would prevent fishermen (either voluntarily or imposed by regulation) from initiating activities in the spill area. This, in turn, could decrease landings and/or the value of catch for several months. However, GOM species can be found in many adjacent locations. The GOM commercial fishermen do not fish in one locale and have responded to past petroleum spills, such as that in Lake Barre in Louisiana, without discernible loss of catch or income by moving elsewhere for a few months (with the exception of the longline closure areas described in **Chapter 3.3.1.**, Commercial Fishing). In the case of a blowout, it is likely that commercial fishermen would actively avoid the immediate area of an active blowout, but this restriction of pelagic fishing activity (longlining) would not represent any additional area not already restricted due to the presence of offshore structures themselves.

Summary and Conclusion

Accidental events resulting from oil and gas development in a proposed action area of the GOM have the potential to cause some detrimental effects on fisheries and fishing practices. A subsurface blowout would have a negligible effect on GOM fish resources or commercial fishing. If spills due to a proposed action were to occur in open waters of the OCS proximate to mobile adult finfish or shellfish, the effects would likely be nonfatal and the extent of damage would be reduced due to the capability of adult fish and shellfish to avoid a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. The effect of proposed-action-related oil spills on fish resources and commercial fishing is expected to cause less than a 1 percent decrease in standing stocks of any population, commercial fishing efforts, landings, or value of those landings. Any affected commercial fishing activity would recover within 6 months. At the expected level of impact, the resultant influence on fish populations and commercial fishing activities within the proposed lease sale area would be negligible and indistinguishable from variations due to natural causes.

It is expected that coastal environmental degradation from a proposed action would have little effect on fish resources or EFH; however, wetland loss could occur due to a petroleum spill contacting inland areas.

4.4.11. Impacts on Recreational Fishing

The discussion of the impacts of accidents on fish resources and commercial fishing also applies to recreational fishing (**Chapter 4.4.10.**). The proposed lease sale area lies at relatively extreme distances from most recreational fishing ports, on the order of 60 nmi or greater. For recreational vessels that may venture into the proposed lease sale area, oil spills and pollution events resulting from possible accidents and events associated with a proposed action could have temporary and minor adverse impacts on recreational fishing. Recreational fishing boats inadvertently contacting spills or pollution caused by accidents associated with activities resulting from a proposed action could be soiled, which may require the fishermen to temporarily modify their fishing plans. Recreational fishermen can be expected to actively avoid the area of a blowout or spill.

Summary and Conclusion

The estimated number and size of potential spills associated with a proposed action's activities (**Chapter 4.3.1.2.**, Risk Charaterization for Proposed Action Spills) are unlikely to decrease recreational fishing activity but may divert the location or timing of a few planned fishing trips.

4.4.12. Impacts on Recreational Resources

Major impact-producing factors associated with offshore oil and gas exploitation are oil spills and tar balls, widely recognized as serious threats to coastal lands, especially recreational beaches. Oil spills can be associated with the exploration, production, and/or transportation phases of OCS operations. Major oil spills contacting recreational beaches can cause short-term displacement of recreational activity from the areas directly affected including closure of beaches for periods of 2-6 weeks, or until the cleanup operations are complete. Factors such as season, extent of pollution, beach type and location, condition and type of oil washing ashore, tidal action, cleanup methods (if any), and publicity can have a bearing on the severity of effects on a recreational beach and its use.

Widely publicized and investigated oil-spill events, such as the Santa Barbara Channel spill of 1969, the *Ixtoc I* spill in June 1979 (Restrepo and Associates, 1982), the *Alvenus* tanker spill of 1984, and the 1989 *Exxon Valdez* tanker spill in Prince William Sound, Alaska, have demonstrated that oil spills >1,000 bbl can severely affect beaches and their recreational use. However, findings from an in-depth study of the *Ixtoc I* oil-spill (600 mi south of Texas in the Bay of Campeche, Mexico) and three south Texas shoreline beach parks (as of September 1979 all of the south Texas coast had been impacted by oil) (http://spills.incidentnews.gov/incidentnews/FMPro?-db=history&-format=history_detail.htm&-lay=history&RecID=32915&-find) indicated no significant decrease in park visitations as a result of the oil spill (Freeman et al., 1985). Sorensen (1990) reviewed the socioeconomic effects of several historic major oil spills on beaches and concluded a spill near a coastal recreation area would reduce visitation in the area by 5-15 percent over one season, but would have no long-term effect on tourism.

Tarballs (the floating residue remaining after an oil slick dissipates) are likely results from a large spill. Tarballs are known to persist as long as 1-2 years in the marine environment. A MMS contractor and staff investigated the abundance and sources of tarballs on the recreational beaches of the CPA. They conclude that the presence of tar balls along the Louisiana coastline is primarily related to marine transportation activities and that their effect on recreational use is below the level of social and economic concern (Henry et al., 1993).

Proposed Action Analysis

Chapter 4.3.1.2.1. discusses the frequency, magnitude, and sources of oil spills estimated from a proposed action. **Figure 4-19** gives the probabilities of offshore spills (≥1,000 bbl) occurring and contacting recreational beach areas within 10 and 30 days.

Summary and Conclusion

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

4.4.13. Impacts on Archaeological Resources

Spills, collisions and blowouts are accidental events that can occur due to oil and gas operations. If an oil spill occurs as a result of one of these events there could be an impact to archaeological resources.

Oil spills have the potential to affect both prehistoric and historic archaeological resources. Impacts to historic resources would be limited to visual impacts and, possibly, physical impacts associated with spill cleanup operations. Impacts to prehistoric archaeological sites from oil spills would result in hydrocarbon contamination of organic materials within the site. Organic materials have the potential to date site occupation through radiocarbon dating techniques. Additional impacts to consider are the possible physical disturbance to the prehistoric site associated with spill cleanup operations.

4.4.13.1. Historic

Should an oil spill contact a coastal historic site, such as a fort or a lighthouse, the major impacts would be a visual, contamination of the site and its environment. The probability of one or more spills ≥1,000 bbl occurring and contacting counties and parishes are listed in **Table 4-34**. The offshore oil-spill scenario numbers are presented in **Chapter 4.3.1.2.**, Risk Charaterization for Proposed Action Spills. Should such an oil spill contact an on-shore historic site, the effects would be temporary and reversible.

Summary and Conclusions

Accidents, associated with oil and gas exploration and development activities as a result of a proposed action, are not assumed to impact historic archaeological resources. As indicated in **Table 4-34**, it is not likely for an offshore oil spill to occur and contact coastal historic archaeological sites from accidental events associated with a proposed action. The major type impact from an oil-spill accidental event would only be visual contamination by physical contact to a historic coastal site, such as a historic fort or lighthouse. It is expected that there would be only minor impacts to historic archaeological resources as a result oil spill cleanup operations. These impacts would be temporary and reversible.

4.4.13.2. Prehistoric

Prehistoric archaeological sites may be damaged by offshore oil spills as the result of an accidental event such as spills caused by faulty oil production equipment, collisions between workboats and other support vessels and/or collisions with oil and gas structures. Prehistoric sites located on barrier islands and along beaches could be subject to oil spill impacts. This direct physical contact by oil on a prehistoric site could coat fragile artifacts or site features with oil and could disturb artifact provenience and site stratigraphy. The result would be the loss of archaeological data on prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts for North America, Central America, South America, and the Caribbean.

According to estimates presented in **Table 4-2**, multisale lease action, between 30 and 40 exploration, delineation, and development wells would be drilled, and 2 production platforms would be installed as a result of a proposed action. Accidental events associated with these exploration, development, and production facilities could contribute to offshore oil spill impacting prehistoric archaeological sites.

The probability for offshore oil spills ≥1,000 bbl occurring from a proposed action and contacting U.S. shorelines are presented in **Table 4-34**. Coastal oil spill scenario numbers are presented in **Table**

4-32. Should an oil spill contact a coastal prehistoric site or a barrier island site, the potential for dating the site using radiocarbon dating could be destroyed. Ceramic or lithic seriation or other relative dating techniques might ameliorate this loss of information. Recent investigations into oil spill archaeological damage associated with the *Exxon Valdez* oil spill in the Gulf of Alaska revealed that oil did not penetrate the subsoil, or into wooden artifacts, in the intertidal zone, apparently because of hydrostatic pressure (Federal Archaeology, Summer, 1994). However, it is premature to extrapolate the results from this study into the GOM coastal environment.

Previously unrecorded coastal prehistoric sites could experience an impact from on-shore oil-spill cleanup operations, including possible site looting. Cleanup equipment could destroy fragile artifacts or site features and could disturb the site context. The result would be the loss of information on the prehistory of North America and the Gulf Coast region. Some of the coastal prehistoric sites that might be impacted by beach cleanup operations may contain unique and significant scientific information. In Louisiana, Mississippi, and Alabama, prehistoric sites occur frequently along the barrier islands and mainland coast and the margins of bays and bayous. Paleo-Indian artifacts have been recovered from barrier islands offshore Mississippi (McGahey, personal communication, 1996). Probabilities an offshore spill ≥1,000 bbl occurring as a result of a proposed action and contacting land within 10 or 30 days are given in **Table 4-34**.

Summary and Conclusion

Oil spills may threaten the prehistoric archaeological resources of the Central and Eastern GOM. Should such an impact occur, unique or significant archaeological information would be lost, and the impacts would be irreversible and could result in the loss of radiocarbon dating potential for the site. Oil-spill cleanup operations could result in the direct disturbance or destruction of artifacts, site features, and site context by cleanup equipment or the looting of sites by cleanup personnel.

4.4.14. Impacts on Human Resources and Land Use

4.4.14.1. Land Use and Coastal Infrastructure

Accidental events such as oil or chemical spills, blowouts, and vessel collisions are not expected to effect land use. Coastal or nearshore spills could have short-term adverse effects on coastal infrastructure requiring clean up of any oil or chemicals spilled.

Summary and Conclusion

Accidental events such as oil or chemical spills, blowouts, and vessel collisions are not expected to effect land use. Coastal or nearshore spills could have short-term adverse effects on coastal infrastructure requiring clean up of any oil or chemicals spilled.

4.4.14.2. Demographics

Accidental events such as oil or chemical spills, blowouts, and vessel collisions are not expected to have any effects on the demographic characteristics of the GOM coastal communities.

Summary and Conclusion

Accidental events such as oil or chemical spills, blowouts, and vessel collisions are not expected to have any effects on the demographic characteristics of the GOM coastal communities.

4.4.14.3. Economic Factors

The resource costs of cleaning up an oil spill, either onshore or offshore, were not included in the economic analyses for a proposed action (**Chapter 4.2.1.15.3.**, Economic Factors) for two reasons. First, the potential impact of oil-spill cleanup activities is a reflection of the spill's opportunity cost. The cleanup and remediation of an oil spill involves the expenditure of millions of dollars and the creation of hundreds of jobs. While such expenditures are revenues to business and employment/revenues to individuals, the cost of responding to a spill is not a benefit to society and is a deduction from any comprehensive measure of economic output. An oil spill's opportunity cost has two generic components: cost and lost opportunity. Cost is the value of goods and services that could have been produced with the resources used to cleanup and remediate the spill if the resources had been able to be used for production or consumption. The second is the value of the opportunities lost or precluded to produce (e.g., harvest oysters) or consume (e.g., recreational/tourism activities) (Pulsipher et al., 1999). The value of lost opportunities is not quantified in this section. The second reason for excluding the costs of cleaning up an oil-spill from the proposed action economic analyses is that the occurrence of a spill is not a certainty. Spills are random accidental events. Even if a proposed EPA lease sale was held, leases let, and oil and gas produced, the timing, numbers, sizes, offshore locations of occurrence, and onshore locations of contact of potential spills occurring over the life of a proposed action are all unknown variables. Additionally, the cost involved in any given cleanup effort is influenced by a variety of factors: whether or not the oil comes ashore; the type of coastal environment contacted by the spill; weather conditions at the time of the incident; the type and quantity of oil spilled; and the extent and duration of the oiling. Nevertheless, the same two-step model used in **Chapter 4.2.1.15.3.** to project employment for a proposed EPA lease sale was applied to project the opportunity cost employment associated with cleaning up an oil spill. In this case, the first step considered estimates of the expenditures resulting from oil-spill cleanup activities should a spill occur and contact land. **Table 4-39** depicts the sectoral allocation of the spending associated with spill cleanup and remediation activities. The amount spent per industrial sector to clean up a spill varies depending on such factors as the water depth in which the spill occurs and whether or not the spill contacts land. In all cases the legal sector receives the majority of oil-spill cleanup expenditures. The second step incorporated the IMPLAN regional model multipliers to translate those expenditures into direct, indirect, and induced employment associated with oil-spill cleanup activities.

Chapter 4.3.1.2., Risk Charaterization for Proposed Action Spills, depicts the risks and number of spills estimated to occur for a proposed EPA lease sale. The average size (on which model results are based) estimated for a spill ≥1,000 bbl is 4,600 bbl. The greatest risk of a spill ≥1,000 bbl occurring from a proposed action is from a pipeline break (9-11% chance). Based on model results, should such a spill occur and contact land, it is projected to cost 363 person-years of employment for cleanup and remediation. The majority of this employment (163 person-years of employment) would occur in TX-2. This is because the greatest expenditures for oil-spill cleanup and remediation activities are allocated to legal services (79%), which would originate from the oil and gas industry corporate offices in Houston, Texas, in Subarea TX-2 (Dismukes et al., 2003). Should a spill of 4,600 bbl occur and not soil land, the model projects a cost of 155 person-years of employment for its cleanup. This represents less than 1 percent of baseline employment for the analysis area even if the spill were to occur during the peak year of employment for an EPA lease sale. The most probable areas to be affected by a spill are Plaquemines and Lafourche Parishes. **Table 4-40** summarizes the direct, indirect, and induced opportunity cost employment (by coastal subarea and planning area) for an oil-spill cleanup should a spill occur and contact land.

Table 4-31 shows that, over the life of a proposed lease sale, spills less than 50 bbl are likely to occur from facilities operating in the proposed lease sale area. It is estimated that between 220 and 290 small (≤1 bbl) spills may occur offshore as a result of a proposed action. A few spills ≥1 bbl and <50 bbl are also estimated to occur offshore. These spills are not expected to reach land since the proposed lease sale area is 70 mi from the nearest shoreline (Louisiana). Whether these spills reach land or not, cleanup employment associated with such small spills is projected to be negligible. Facilities are equipped and employees are trained for such occurrences. The assumed size for a spill in the Spill Size Group 10 to <50 bbl is a 20 bbl spill with a 65-75 percent chance that one or more spills in that size group would occur. Should such a spill occur, the model estimates an opportunity cost of no more than 2 person-years of employment and expenditures of $38.2-90.0 thousand that could have gone to production or consumption rather than to spill-cleanup efforts. The immediate social and economic consequences for the region in which a spill occurs are a mix of things that include not only additional opportunity cost jobs and sales but also nonmarket effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations. These negative short-term social and economic consequences of an oil spill are expected to be modest as measured by projected cleanup expenditures and the number of people employed in cleanup and remediation activities. Negative long-term economic and social impacts may be more substantial if fishing, shrimping, oystering, and/or tourism were to suffer or were to be perceived as having suffered because of the spill (Pulsipher et al., 1999). **Chapters 4.4.10. and 4.4.12.** include additional discussions of the potential consequences of an oil spill on commercial fisheries and recreational beaches.

Overall employment projected for all OCS oil and gas activities includes employment in the oil-spill response industry. Overall OCS employment is projected to be substantial (up to 6% of baseline employment in some subareas).

Tarballs (the floating residue remaining after an oil slick dissipates) are likely results from a large spill. Tarballs are known to persist as long as 1-2 years in the marine environment. Findings from an MMS study investigating the abundance and sources of tarballs on the recreational beaches of the CPA concluded that the presence of tarballs along the Louisiana coastline is primarily related to marine transportation activities and that their effect on recreational use is below the level of social and economic concern (Henry et al., 1993).

Summary and Conclusion

The short-term social and economic consequences for the GOM coastal region should a spill ≥1,000 bbl occur includes opportunity cost of 155-363 person-years of employment and expenditures of $8.8-20.7 million that could have been gone to production or consumption rather than spill-cleanup efforts. Non-market effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations are also expected to occur in the short-term. These negative, short-term social and economic consequences of an oil spill are expected to be modest in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities. Negative, long-term economic and social impacts may be more substantial if fishing, shrimping, oystering, and/or tourism were to suffer or were to be perceived as having suffered because of the spill.

4.4.14.4. Environmental Justice

Oil spills that enter coastal waters can have negative economic or health impacts on the many people who use them for fishing, diving, boating, and swimming. Should an oil spill occur and adversely impact coastal areas, its effects are not expected to disproportionately impact minority or low-income populations. The populations immediately adjacent to the coast (Jefferson County, Texas, to Gulf County, Florida) and the users of the coast and coastal waters are not physically, culturally, or economically homogenous. Coastal concentrations of minority and poor populations are few and mostly urban (**Figures 3-14 and 3-15**). Gentrification along the coast is enduring; the homes and summer homes of the relatively affluent increasingly occupy much of the Gulf Coast. If a proposed action-related oil spill (≥1,000 bbl) were to occur and contact land, the most likely counties or parishes along the GOM to be contacted (>0.5% risk of contact within 10 or 30 days) are Plaquemines and Lafourche Parishes in Louisiana (**Figure 4-18** and **Chapter 4.3.1.2.**, Risk Charaterization for Proposed Action Spills). Located next to Plaquemines Parish, Grand Isle is the only inhabited Louisiana barrier island; this community's population is neither predominately minority or poor. Recreational users of coastal waters tend to be relatively affluent. For example, a recent survey of recreational and party-boat fishing around offshore oil rigs found significant per capita costs (Hiett and Milon, 2002). Thus, any impacts, occurring from an oil spill are not expected to disproportionately affect minority or low-income populations. Oil spills can have indirect effects such as impacts on tourism. If a proposed action-related oil spill were to occur and contact land in a tourist area, workers in the hotel and restaurant industry would be affected for a short period of time, as would the local economy. However, these too are unlikely to disproportionately affect minority or poor people.

Summary and Conclusion

Considering the population distribution along the GOM, a proposed action is not expected to have a disproportionate adverse environmental or health effect on minority or low-income people.