CHAPTER 4

ENVIRONMENTAL AND SOCIOECONOMIC CONSEQUENCES

4. ENVIRONMENTAL AND SOCIOECONOMIC CONSEQUENCES

4.1. IMPACT-PRODUCING FACTORS AND SCENARIO – ROUTINE OPERATIONS

4.1.1. Offshore Impact-Producing Factors and Scenario

This section describes the offshore infrastructure and activities (IPF's) associated with a proposed action that could potentially affect the biological, physical, and socioeconomic resources of the GOM. When appropriate, offshore IPF's associated with the Gulfwide OCS Program are discussed because some proposed action, IPF's (i.e., infrastructure) affect resources that are geographically Gulfwide and, therefore, are necessary for the cumulative analysis. The Gulfwide OCS Program is composed of the Eastern, Central, and Western Planning Areas. Offshore is defined here as the OCS portion of the GOM that begins 10 mi offshore Florida; 3 mi offshore Louisiana, Mississippi, and Alabama; and 3 leagues offshore Texas; and it extends seaward to the limits of the EEZ (**Figure 1-1**). Coastal infrastructure and activities associated with a proposed action and the Gulfwide OCS Program are described in **Chapter 4.1.2.**, Coastal Impact-Producing Factors and Scenario.

Offshore activities are described in the context of scenarios for a proposed action and for the Gulfwide OCS Program. The MMS's GOM OCS Region developed these scenarios to provide a framework for detailed analyses of potential impacts of the proposed lease sales. Each scenario is a hypothetical framework of assumptions based on estimated amounts, timing, and general locations of OCS exploration, development, and production activities and facilities, both offshore and onshore. A proposed action is represented by a set of ranges for resource estimates, projected exploration and development activities, and impact producing factors. Each of the proposed sales is expected to be within the scenario ranges; therefore, a proposed action is representative of either proposed Lease Sale 189 or Lease Sale 197. The scenarios do not predict future oil and gas activities with absolute certainty, even though they were formulated using historical information and current trends in the oil and gas industry. Indeed, these scenarios are only approximate since future factors such as the contemporary economic marketplace, the availability of support facilities, and pipeline capacities are all unknowns. Notwithstanding these unpredictable factors, the scenarios used in this EIS represent the best assumptions and estimates of a set of future conditions that are considered reasonably foreseeable and suitable for presale impact analyses. The development scenarios do not represent an MMS recommendation, preference, or endorsement of any level of leasing or offshore operations, or of the types, numbers, and/or locations of any onshore operations or facilities.

The assumed life of the leases resulting from a proposed lease sale does not exceed 40 years. This is based on averages for time required for exploration, development, production life, and abandonment for leases in the GOM. For the cumulative analysis, the Gulfwide OCS Program is discussed in terms of current activities, current trends, and projections of these trends into the reasonably foreseeable future. For modeling purposes and quantified Gulfwide OCS Program activities, a 40-year analysis period (year of the first lease sale (2003) through 38 years after the second lease sale (2005) as proposed in the 5-Year Program for 2002-2007) is used. Activity projections become increasingly uncertain as the length of time for projections are made increases and the number of influencing factors increases. The projections used to develop a proposed action and Gulfwide OCS Program scenarios are based on resource and reserves estimates as presented in the *2000 Assessment of Conventionally Recoverable Hydrocarbon Resources of the Gulf of Mexico and Atlantic Outer Continental Shelf as of January 1, 1999* (Lore et al., 2001), current industry information, and historical trends.

The statistics used for these historic trends exhibit a lag time of about two years; therefore, the models using the trends also reflect two-year-old statistics. In addition, the overall trends average out the "boom and bust" nature of GOM OCS operations. The models cannot fully adjust for short-term changes in the rates of activities. In fact, these short-term changes should not be projected into the long term. An example of a short-term change was the surge in deepwater activities in the mid-1990's as a result of technological advancements in seismic surveying and development options, as well as a reflection of deepwater royalty relief. This short-term effect was greater than the activity level predicted by the resources and socioeconomic models. The MMS believes that the models, with continuing adjustments and refinements, adequately project GOM OCS activities in the long term for the EIS analyses.

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

- recent trends in the amount and location of leasing, exploration, and development activity;
- estimates of undiscovered, unleased, conventionally recoverable oil and gas resources in the planning area;
- existing offshore and onshore oil and/or gas infrastructure;
- industry information; and
- oil and gas technologies, and the economic considerations and environmental constraints of these technologies.

The proposed actions are Lease Sales 189 and 197, as scheduled in the *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007*. In general, a proposed lease sale represents 15-19 percent of the OCS Program in the EPA based on barrels of oil equivalent (BOE) resource estimates. Activities associated with a proposed lease sale in the EPA are assumed to represent 15-19 percent of OCS Program activities in the EPA unless otherwise indicated. In general, a proposed lease sale represents less than 1 percent of the Gulfwide OCS Program based on BOE resource estimates. Activities associated with a proposed action are assumed to represent less than 1 percent of Gulfwide OCS Program activities and impacts unless otherwise indicated.

Specific projections for activities associated with a proposed action are discussed in the following scenario sections. The potential impacts of the activities associated with a proposed action are considered in the environmental analysis sections (**Chapters 4.2.1. and 4.4.**).

The Gulfwide OCS Program scenario includes all activities that are projected to occur from past, proposed, and future lease sales during the analysis period. Activities that take place beyond the analysis timeframe as a result of future lease sales are not included in this analysis. The impacts of activities associated with the Gulfwide OCS Program on biological, physical, and socioeconomic resources are analyzed in the cumulative environmental analysis section (**Chapter 4.5.**).

4.1.1.1. Resource Estimates and Timetables

4.1.1.1.1. Proposed Action

A proposed action's scenarios are used to assess the potential impacts of a proposed lease sale. The resource estimates for a proposed action are based on two factors: (1) the conditional estimates of undiscovered, unleased, conventionally recoverable oil and gas resources in the proposed lease sale areas; and (2) estimates of the portion or percentage of these resources assumed to be leased, discovered, developed, and produced as a result of a proposed action. The estimates of undiscovered, unleased, conventionally recoverable oil and gas resources are based upon a comprehensive appraisal of the conventionally recoverable petroleum resources of the Nation as of January 1, 1999. Due to the inherent uncertainties associated with an assessment of undiscovered resources, probabilistic techniques were employed and the results were reported as a range of values corresponding to different probabilities of occurrence. A thorough discussion of the methodologies employed and the results obtained in the assessment are presented in the MMS report *2000 Assessment of Conventionally Recoverable Hydrocarbon Resources of the Gulf of Mexico and Atlantic Outer Continental Shelf as of January 1, 1999* (Lore et al., 2001). The estimates of the portion of the resources assumed to be leased, discovered, developed, and produced as a result of a proposed action are based upon logical sequences of events that incorporate past experience, current conditions, and foreseeable development strategies. A profusion of historical databases and information derived from oil and gas exploration and development activities are available to MMS and were used extensively. The undiscovered, unleased, conventionally recoverable resource estimates for a proposed action are expressed as ranges, from low to high. The range reflects a range of projected economic valuations of the produced oil and gas. The "low" end of the range is based on an economic case of $18 per barrel of oil and $2.11 per thousand cubic feet (Mcf) for gas. The "high" estimate is based on an economic case of $30 per barrel of oil and $3.52 per Mcf for gas.

Table 4-1 presents the projected oil and gas production for a proposed action and for the Gulfwide OCS Program. **Table 4-2** provides a summary of the major scenario elements of a proposed action and some of the related impact producing factors. To analyze impact producing factors for a proposed action and the Gulfwide OCS Program, the proposed lease sale area was divided into two offshore subareas based upon ranges in water depth (1,600-2,400 m and >2,400 m). **Figure 3-10** depicts the location of the offshore subareas. The water-depth ranges reflect the technological requirements and related physical and economic impacts as a consequence of the oil and gas potential, exploration and development activities, and lease terms unique to each water-depth range. Estimates of resources and facilities are distributed into each of the subareas.

The estimated amounts of resources projected to be leased, discovered, developed, and produced as a result of a proposed lease sale are 0.065-0.085 BBO and 0.265-0.340 Tcf of gas. The number of exploration and delineation wells, production platforms, and development wells projected to develop and produce the estimated resources for a proposed action is given in **Table 4-2**. The table shows the distribution of these factors by offshore subareas in the proposed lease sale area. **Table 4-2** also includes estimates of the major impact producing factors related to the projected levels of exploration, development, and production activity.

For purposes of analysis, the life of the leases resulting from a proposed action is assumed to not exceed 40 years. Exploratory drilling activity takes place over a 16-year period, beginning in one year after the lease sale. Development activity takes place over an 18-year period, beginning with the installation of the first production platform and ending with the drilling of the last development wells. Production of oil and gas begins by the fourth year after the lease sale and continues through the 35^{th} year. Final abandonment and removal activities occur in the 37^{th} year.

4.1.1.1.2. Gulfwide OCS Program

Gulfwide OCS Program: Projected reserve/resource production for the Gulfwide OCS Program (15.49-22.42 BBO and 153.42-207.98 Tcf of gas) represents anticipated production from lands currently under lease plus anticipated production from future lease sales over the 40-year analysis period. **Table 4-3** presents projections of the major activities and impact producing factors related to future Gulfwide OCS Program activities.

Eastern Planning Area: Projected reserve/resource production for the OCS Program in the EPA (0.14-0.37 BBO and 2.49-3.54 Tcf of gas) represents anticipated production from lands currently under lease in the EPA plus anticipated production from future EPA lease sales over the 40-year analysis period. Projected production represents less than 1-2 percent of the oil and approximately 2 percent of the gas of the total Gulfwide OCS Program. **Table 4-4** presents projections of the major activities and impact producing factors related to future operations in the EPA.

Central Planning Area: Projected reserve/resource production for the OCS Program in the CPA (12.00-16.52 BBO and 108.27-146.27 Tcf of gas) represents anticipated production from lands currently under lease in the CPA, plus anticipated production from future CPA lease sales over the 40-year analysis period. Projected production represents approximately 74-78 percent of the oil and 70 percent of the gas of the total Gulfwide OCS Program. **Table 4-5** presents projections of the major activities and impact producing factors related to future operations in the CPA.

Western Planning Area: Projected reserve/resource production for the OCS Program in the WPA (3.35-5.53 BBO and 42.66-58.17 Tcf of gas) represents anticipated production from lands currently under lease in the WPA plus anticipated production from future WPA lease sales over the 40-year analysis period. Projected production represents approximately 22-25 percent of the oil and 28 percent of the gas of the total Gulfwide OCS Program. **Table 4-6** presents projections of the major activities and impact producing factors related to future operations in the WPA.

4.1.1.2. Exploration and Delineation

Prelease exploration activity centers on prospecting for promising accumulations of oil and gas on unleased OCS blocks. “Prospecting” in deep water, like the proposed lease sale area, necessarily involves analyzing data collected by an array of tools that remotely sense the geology below the sea bottom, and skilled explorationists (i.e., geologists, geophysicists, and engineers) conceptualizing where oil and gas might be found. Prior to a lease sale, oil and gas operators evaluate available G&G data in order to decide upon lease prospects. Geophysical data used in exploration focuses on seismic surveys that record the speed at which compressional waves move through sediment, rocks, and fluids they contain. A variety of data sources are accessed in this evaluation: in-house operator, operator consortia, purchased from vendors, university consortia, and open literature. Lease prospects are ranked by operators using G&G data, proprietary methodologies, and economic criteria to determine a dollar amount for lease sale bidding.

When an operator successfully acquires an OCS lease, a period of postlease prospect maturation begins. Maturation refers to a suite of concurrent activities whereby data and analyses are assembled to a state of completeness or sophistication that permits management to decide whether or not to invest in an exploration program. During prospect maturation, explorationists apply various techniques and tools to examine specific G&G qualities, perform special processing on the seismic data, and/or apply software to manipulate large datasets. Previous assumptions and conclusions about the lease's prospects are revisited and new ideas are tested. Operators usually rank mature prospects again using proprietary economic models, an internal risk evaluation team, various kinds of decision trees, and/or structured scenarios. The process is designed to increase the likelihood that the drilled prospect is a discovery and a dry hole is averted.

Operators use drilling terms that characterize stages in the discovery and production of hydrocarbon resources. An exploration well generally refers to the first well drilled on a unproven or semi-proven basin or territory to determine if a resource exists. If the geologic area, basin, or "play" has not been tested before, the term wildcat exploration well is sometimes used. If a resource is discovered or if the operator is uncertain whether or not an economic discovery has been made, a delineation well may be drilled. Delineation wells help define how big a structure might be, the geographic extent of the reservoir rock, the amount of resource in the discovery "pay zones," and the ease that a formation can be produced (i.e., porosity and permeability). A delineation well can be a separate well or a "sidetrack." The operator uses the initial exploration well to drill a sidetrack well. The bit drills through the sidewall of the existing well bore at an angle (deviation) to test a different layer or structure. A sidetrack well can test for the same data at lower cost because a drill rig does not need to be de-mobilized, moved, and re-mobilized at a different location.

In 2002, MMS analyzed success rates of exploration wells for the 1995-2000 period. For water depths greater than 200 m, the geologic success rate for exploration wells has been between 30 and 40 percent. Conversely, approximately 60-70 percent of these wells were dry holes. Geologic success is distinguished from economic success because a geologically successful well may not be economic to produce. A deepwater exploration well is a very expensive investment; therefore, operators are highly motivated to engage the best technology available so that the chance for a discovery and economic return is increased.

4.1.1.2.1. Seismic Surveying Operations

Geophysical seismic surveys are performed to obtain information on surface and near-surface geology and on subsurface geologic formations. The MMS is currently completing a programmatic EA on G&G permitted activities in the GOM (USDOI, MMS, in preparation), which includes a detailed description of seismic surveying technologies and operations. It is incorporated here by reference and summarized below. High-resolution surveys done in support of lease operations are authorized under the terms and conditions of the lease agreement, and are referred to as postlease surveys. Prelease surveys take into account similar seismic work performed off-lease and collectively authorized under MMS's G&G permitting process.

High-resolution seismic surveys collect data on surficial geology used to identify potential shallow geologic hazards for engineering and site planning for bottom-founded structures. They are also used to identify environmental resources such as chemosynthetic community habitat. Deep-penetration, CDP seismic surveys obtain data about geologic formations greater than 10,000 m (32,800 ft) below the seafloor. High-energy, marine seismic surveys include both 2D and 3D surveys. Data from 2D/3D surveys are used to map structural features of stratigraphically important horizons in order to identify potential hydrocarbon traps. They can also be used to identify and map habitats for chemosynthetic communities.

Prior to 1989, explosives (dynamite) were used in certain limited areas to generate seismic pulses needed for the surveys. However, the damaging environmental impacts associated with explosives' acoustical energy (high velocity and high peak pressure) led the seismic industry to replace the explosives with seismic airguns. Considered nonexplosive, the piston-type airguns use compressed air to create impulses with superior acoustic signals without generating the environmental impacts of explosives. Due to the decreased impacts, ease of deployment, and reduced regulatory timeframes that come with using airguns, it is assumed that no explosives would be used in future seismic surveys.

Typical seismic surveying operations tow an array of airguns and a streamer (signal receiver cable) behind the vessel 5-10 m below the sea surface. The airgun array produces a burst of underwater sound by releasing compressed air into the water column that creates an acoustical energy pulse. Depending on survey type and depth to the target formations, the release of compressed air every couple of seconds creates a regular series of strong acoustic impulses separated by silent periods lasting 7-16 seconds. Airgun arrays are designed to focus the sound energy downward. Acoustic (sound) signals are reflected off the subsurface sedimentary layers and recorded near the water surface by hydrophones spaced within streamer cables. These streamer cables are often 3 mi or greater in length. Vessel speed is typically 4.5-6 knots (about 4-8 mph) with gear deployed.

The 3D seismic surveying enables a more accurate assessment of potential hydrocarbon reservoirs to optimally locate exploration or development wells and minimize the number of wells required to develop a field. State-of-the-art computers have the power to manipulate and process large tracks of 3D seismic data. The 3D surveys carried out by seismic vendors can consist of several hundred OCS blocks. Multiple-source and multiple-streamer technologies are used for 3D seismic surveys. A typical 3D survey might employ a dual array of 18 guns per array. Each array might emit a 3,000-in^3 burst of compressed air at 2,000 pounds per square inch (psi), generating approximately 4,500 kilojoule (kJ) of acoustic energy for each burst. At 10 m from the source, the pressure experienced is approximately ambient pressure plus 1 atmosphere (atm). The streamer array might consist of 6-8 parallel cables, each 6,000-8,000 m long, spaced 75 m apart. A series of 3D surveys collected over time, commonly referred to as a four-dimensional, 4D, or time-lapse survey, is used for reservoir management (to monitor how a reservoir is draining to optimize the amount of hydrocarbon that is produced).

Multicomponent data, sometimes referred to as 4C data, is a product of an emerging technology that incorporates recording the traditional seismic compressional (P) waves with a full complement of other wave types, but predominantly shear (S) waves. The 4C technology provides a second independent image of a geologic section as well as improves the lithology picture in structurally complex areas. It can also aid in reservoir fluid prediction. The 4C data may be 2D or 3D in nature and procedurally involves draped or towed ocean-bottom receiver cable(s) for acquisition. The 4C data can be used as a defining prelease tool or a postlease aid for reservoir prediction.

Postlease seismic surveying may include high-resolution, 2D, 3D, or 4D surveying. In addition, multicomponent data (2D-4C and 3D-4C data) may be collected to improve lithology and reservoir prediction. High-resolution surveying is done on a site-specific or lease-specific basis or along a proposed pipeline route. These surveys are used to identify potential shallow, geologic hazards for engineering and site planning for bottom-founded structures. They are also used to identify environmental resources such as hard-bottom areas, topographic features, potential chemosynthetic community habitat, or historical archaeological resources. New technology has allowed for 3D acquisition and for deeper focusing of high-resolution data. It is assumed at least one postlease, high-resolution seismic survey would be conducted for each lease.

Deeper penetration seismic surveying (2D, 3D, or 4D) may also be done postlease for more accurate identification of potential reservoirs, increasing success rates for exploratory drilling and aiding in the identification of additional reservoirs in "known" fields. The 3D technology can be used in developed areas to identify bypassed hydrocarbon-bearing zones in currently producing formations and new productive horizons near or below currently producing formations. It can also be used in developed areas for reservoir monitoring and field management. The 4D seismic surveying is used for reservoir monitoring and management, as well as in identifying bypassed "pay zones." Through time-lapsed surveys, the movement of oil, gas, and water in reservoirs can be observed over time. Postlease, deep seismic surveys may occur periodically throughout the productive life of a lease.

From 1996 to 2001, the number of prelease geophysical permits Gulfwide has been consistently high, averaging over 100 permits a year. The majority of these permits are related to the cyclic nature (7-9 years) of seismic surveys; more state-of-the-art 2D and 3D seismic surveys would be run in mature regions of the CPA and WPA where inadequate and dated seismic coverage currently exists. Due to the smaller size of the proposed lease sale area and the recent completion of available surveys (1999 and 2000), prelease surveys for a proposed action are projected to be random and limited. The MMS estimates that only one or two prelease seismic surveys per year may be applied for and permitted as a result of a proposed action. For OCS Program activities in the EPA for the years 2003-2042, 40-80 prelease seismic surveys may be permitted, with the majority occurring during years 2009-2010, 2019-2020, and 2029-2030.

Developing technologies may provide additional detail on the geology and fluids beneath the seafloor that can have applications for the deepwater areas of the GOM. These technologies include vertical cables, marine vibrators, and combinations of multiple vessels, source arrays, and streamers.

4.1.1.2.2. Exploration and Delineation Drilling Plans

An EP must be submitted to MMS for review and approval before any on-site exploration activities can begin on a leased block. Two versions of the EP are produced by the operator for MMS. One version is a proprietary copy that remains on file with MMS. It contains information such as the operator's structure maps, interpreted seismic and structural cross sections showing the operator's evaluation of the prospective structure. The second version is for public access and contains everything that the proprietary version contains except the competitive data noted above. An EP can include exploration programs with multiple wells. Such an approach gives the operator greater flexibility in planning for mechanical problems and provides alternatives and contingencies.

The required contents of an EP include descriptions of the following: (1) the location(s) of the exploration well(s) on the lease block; (2) the drill rig or ship expected to be used; (3) the geologic horizon(s) and age of the prospect; (4) the bathymetric maps, geologic structure maps, seismic velocity data, and interpreted seismic and structural cross sections; (5) a description and schedule of exploration activities; and (6) the environmental monitoring plans and compliance certifications. Upon receipt of an operator's complete EP, MMS reviews it for compliance with all applicable laws and regulations and provides a response and finding within 30 days. The MMS performs technical and environmental reviews for shallow geologic hazards (unstable sea bottom or surface-breaking faults) and manmade hazards (such as existing pipelines), archaeological resources, endangered species, H_2S, sensitive biological features (chemosynthetic communities), water and air quality, oil-spill response, socioeconomic issues, and other competing OCS uses (e.g., military operations). Review of the EP may result in a CER or an EA and/or EIS that must be prepared in support of the NEPA environmental review. The CER, EA, and/or EIS are based on available information. Guidelines and environmental information requirements for lessees and operators submitting an EP are addressed in 30 CFR 250.203 and further explained in NTL 2002-G08. Additional information required includes (1) a geophysical report (for determining the potential for the presence of deepwater benthic communities), (2) an archaeological report, (3) air emissions data, (4) a live-bottom survey and report, (5) a biological monitoring plan, and (6) recommendations by the affected State(s), DOD, FWS, NOAA Fisheries, and/or internal MMS offices. As part of the review process, EP's and supporting environmental information are sent to the affected State(s) for consistency certification review and determination under each State's approved CZM program.

After EP approval and prior to conducting drilling operations, the operator is required to submit and obtain approval for an APD. The APD requires additional equipment and hardware specifications, rig certifications, and data beyond that contained in the EP (i.e., the mud weight and casing program for control of the well).

4.1.1.2.3. Exploration and Delineation Drilling

Exploration and delineation wells in the proposed lease sale area are assumed to be drilled with MODU's. Those capable of being deployed in the proposed lease sale area's water depths (1,600-3,000 m or 5,250-9,850 ft) include (1) conventionally-moored semisubmersibles (semis) (those anchored to the bottom with a chain catenary or tension moorings), (2) DP semisubmersibles (semi), (3) conventionally-moored drillships, and (4) DP drillships (**Figure 4-1**).

The water depth limit for conventionally-moored semis is approximately 2,500 m (8,550 ft). Most of the proposed lease sale area, therefore, is within the capability of this class of MODU's, but not the entire area. In March 2002, Shell set an ultra-deepwater world record in the GOM for a non-DP, conventionally-moored semi of 2,775 m (9,100 ft) (depth of deepest anchor) (Offshore-Technology website; www.offshore-technology.com).

Dynamic positioning refers to the system of propeller jets that gyroscopically accommodate for movement of the ship in winds and currents to keep the drill rig assembly stable and in the same location.

DP semis can operate in water depths up to approximately 3,000 m (RigZone website; http://www.rigzone.com). The DP semis have a depth of operation about 500 m greater than conventionally-moored semis and have the advantage that they do not disturb the sea bottom with anchors. The DP drillships have about the same or a slightly deeper capability than DP semis, depending on the technology deployed. Drillships are constructed to, or adapted to, integrate a drill rig assembly and its support facilities into a floating hull. Because of their size, DP drillships are used in the deepest water (>3,000 m; >9,800 ft). The practical ultra-deepwater drilling depth limits are currently around 3,050 m (10,000 ft). The RigZone website shows that very few rigs built for deepwater exploration have drilling capability beyond 10,000 ft, and those that do are DP drillships.

Day rates for deepwater MODU's fluctuate significantly depending on industry activity levels. In May 2002 day rates for DP drillships were reported as $149,000 (RigZone website; http://www.rigzone.com). Day rates for semisubmersibles were $86,000-$94,000 for 2nd and 3rd generation rigs, with a marketed utilization rate of 75 percent. RigZone's semisubmersible categorization of 1st through 5th generation makes it difficult to correlate a semis generation to a depth range or DP capability. In July 2000 RigZone reported day rates for semisubmersibles as $27,500-$139,000, with a marketed utilization rate of 100 percent.

The type of rig chosen to drill a prospect depends primarily on water depth. Most operators in the GOM OCS refer to deepwater as depths beyond 300 m (1,000 ft), while the term ultra-deep refers to depths beyond 1,000 m (3,280 ft). Since the water-depth ranges for each type of drilling rig overlap, other factors such as availability and day rates are also considered when deciding upon the type of rig to use. The table below indicates the depth ranges used in this analysis for GOM MODU's.

Drilling Rig Type	Water-Depth Range
Conventionally-Moored Semisubmersible	>600 m, <2,600 m
DP Semisubmersible	>600 m, <3,000 m
Drillship	>600 m

The Gulfwide OCS Program scenario projects 6 weeks (42 days) as the average duration for an exploration well to reach total depth; however, the range (30-100 days) can be great. Longer times on station can occur when problems with the equipment, weather or currents, or the geology are encountered. Other variables that influence the duration of an exploration well include (1) the depth of the prospect's potential target zone, (2) the complexity of the well design, and (3) the directional offset (deviation) of the wellbore needed to reach a particular zone.

Figure 4-2 represents a generic well schematic for an exploration well in the proposed lease sale area. The generic well design was derived from actual well-casing programs from nearby projects in the Mississippi Canyon and DeSoto Canyon OCS areas and from internal MMS data. A generic well configuration cannot capture all of the possible configurations that might impact the well design that are caused by (1) unique geologic conditions at a specific well location, (2) directional drilling requirements, (3) potential sidetrack(s), or (4) company preferences. For exploratory wells, contingencies (such as anticipated water-flow zones in the formation) must also be considered in the casing program.

The drilling of a deepwater exploration well begins with setting the first of many sections, or strings, of casing (steel tube). Each casing section is narrower than the preceding one, and each change in casing diameter is separated by a "shoe" (**Figure 4-2**). The drillstring (pipe and bit) drills the wellbore inside the casing. The first casing set at the sea bottom (or mudline) can be large, approximately 30-40 in (75-100 cm) in diameter, especially when drilling through salt to reach subsalt objectives. The first string is emplaced by "jetting" out the unconsolidated sediment with a water jet as the largest casing pipe is set in place. The casing is cemented to the formation by forcing cement downhole to squeeze up and around the outside of the pipe and the wall of the geologic formation. This seal is tested with a pressure test. Because the shallow sediments are soft and unconsolidated, the next casing intervals (a thousand feet or more below mudline) are commonly drilled with treated seawater without a riser (a steel-jacketed tube that connects the well head to the drill rig and within which the drilling mud and cuttings circulate). Drilling mud is generally not used when a riser is not used, and the formation cuttings are discharged from the wellbore directly to the sea bottom. After the blowout preventer (BOP) is installed, commonly at the sea bottom, the riser is connected and circulation for drilling muds and cuttings between the well bit and the surface rig is established.

Next, a repetitive procedure takes place until the well reaches its planned total depth: (1) drill to next casing point, (2) install the casing, (3) cement the casing, (4) test the seal, and (5) drill through the cement shoe and downhole until the next casing point is reached and a narrower casing string is then set. The casing points are determined by downhole formation pressure that is predicted before drilling with seismic wave velocities. As the well deepens, extra lengths of pipe (each about 100 ft long) are screwed onto the drillstring at the surface to extend length to the cutting bit. The downtime needed to install extra lengths of drill pipe is referred to as "tripping" into or out of the hole. The bottom of a well is commonly open and uncased before the well is completed.

The MMS mandates that operators conduct their offshore operations in a safe manner. Subpart D of MMS's operating regulations (30 CFR 250) provides guidance to operators on drilling activities. For example, operators are required by 30 CFR 250.400 to take necessary precautions to keep their wells under control at all times using the best available and safest drilling technology (NTL 99-G01). Deepwater areas pose some unique concerns regarding well control. In 1998, the International Association of Drilling Contractors (IADC) published deepwater well-control guidelines (IADC, 1998) to assist operators in this requirement. These guidelines address well planning, well-control procedures, equipment, emergency response, and training.

As exploration drilling occurs in progressively deeper waters, operators may consider using MODU's that have onboard hydrocarbon storage capabilities. This option may be exercised if a well requires extended flow testing (1-2 weeks or longer) in order to fully evaluate potential producible zones and to justify the higher costs of deepwater development activities. The liquid hydrocarbons resulting from an extended well test could be stored and later transported to shore for processing. Operators may also consider barging hydrocarbons from test wells to shore. There are some dangers inherit with barging operations if adverse weather conditions develop during testing. If operators do not choose to store produced liquid hydrocarbons during the well testing, they must request and receive approval from MMS to flare test hydrocarbons.

Between 1992 and 2001, the average number of rigs drilling in GOM deepwater (>305 m or 1,000 ft) jumped dramatically from 3 to 43 rigs (Baud et al., 2002). Competition for deepwater drilling rigs in the GOM may limit the availability of these MODU's to drill deepwater prospects. Drilling activities may also be constrained by the availability of rig crews, risers, and other equipment.

Proposed Action Scenario: **Table 4-2** shows the range of exploration and delineation wells by water depth subarea. It is estimated that 11-13 exploration and delineation wells would be drilled as a result of a proposed action. These wells are projected to be drilled over a 16-year period beginning two years after a proposed lease sale, with a maximum of three drilled during one year. The exploration and delineation scenario assumes 42 days to reach total depth.

Gulfwide OCS Program Scenario: It is estimated that 8,996-11,333 exploration and delineation wells would be drilled Gulfwide as a result of the OCS Program. **Table 4-3** shows the estimated range of exploration and delineation wells by water depth subarea. Of these wells, approximately 0.5-0.7 percent would be in the EPA, 76-79 percent in the CPA, and 20-24 percent in the WPA. Activity is projected to be relatively stable for the first 10 years of the analysis period, followed by a steady reduction in the annual rate of exploration and delineation wells.

4.1.1.3. Development and Production

According to 30 CFR 250.105, exploration means the commercial search for oil, gas, or sulfur. Delineation is any additional well needed by the lessee to decide whether to proceed with development and production. Development means those activities that take place following the discovery of minerals in paying quantities. Production means those activities that take place after the successful completion of any means for the removal of minerals.

4.1.1.3.1. Development and Production Plans

In 1992, MMS formed an internal Deepwater Task Force to address technical issues and regulatory concerns relating to deepwater (greater than 1,000 ft or 305 m) operations and projects utilizing subsea technology. Based on the Deepwater Task Force's recommendation, an NTL was developed, which required operators to submit a DWOP for all operations in deep water and all projects using subsea technology (currently NTL 2000-N06). A DWOP is intended to explain an operator's conceptual design for a production program while plans are in a formative and flexible stage that can adapt to changes before capital expenditures for equipment are finalized. The DWOP step was established to address regulatory issues and concerns that were not addressed in the existing MMS regulatory framework, and it is intended to initiate an early dialogue between MMS and industry before major capital expenditures on deepwater and subsea projects are committed. Deepwater technology has been evolving faster than MMS's ability to revise OCS regulations; the DWOP was established through the NTL process, which provides for a more timely and flexible approach to keep pace with the expanding deepwater operations and subsea technology. The DWOP requirements are being incorporated into MMS operating regulations via the proposed rulemaking for revisions to 30 CFR 250 Subpart B.

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

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

One of MMS's primary responsibilities is to ensure development of economically producible reservoirs according to sound conservation, engineering, and economic practices as cited in 30 CFR 250.202(a), 250.203(b)(21), 250.204(b)(17), and 250.1101(a). The MMS has established requirements for the submission of conservation information (NTL 2000-N05) for production activities. Operators should submit the necessary information as part of their Supplemental POE and Initial and Supplemental DOCD. Conservation reviews are performed to ensure that economic reserves are fully developed and produced.

A DOCD must be submitted to MMS for review and decision before any development operations can begin on a lease. A DOCD is analogous to an Exploration Plan, but applicable to the development phase of postlease activity. The boundary between activities governed by an EP and a DOCD are transitional in the same way that postlease phases of exploration and development are transitional.

A DOCD describes the proposed development activities, drilling activities, structure facilities, production operations, environmental monitoring plans, and other relevant information. It also includes a schedule of development and production activities. Requirements for lessees and operators submitting a DOCD are addressed in 30 CFR 250.204. Information guidelines for DOCD's are given in NTL 2002-G08.

After receiving a complete DOCD, MMS performs technical and environmental reviews for compliance with all applicable laws and regulations. The MMS evaluates the proposed activity for potential impacts relative to shallow geologic hazards and manmade hazards (including existing pipelines), archaeological resources, endangered species, sensitive biological features, water and air quality, H_2S, oil-spill response, socioeconomic issues, and other competing OCS uses (e.g., military operations).

A CER, EA, and/or EIS are prepared in support of the NEPA environmental review of a DOCD. The CER, EA, and/or EIS is based on available information, which may include (1) a geophysical report (for determining the potential for the presence of deepwater benthic communities, (2) an archaeological report, (3) air emissions data, (4) a live-bottom survey and report, (5) a biological monitoring plan, and (6) recommendations by the affected State(s), DOD, FWS (for selected plans under provisions of a DOI agreement), NOAA Fisheries, and/or internal MMS offices. As part of the review process, the DOCD and supporting environmental information may be sent to the affected State(s) for consistency certification review and determination under each State's approved CZM program. The OCSLA (43 U.S.C. 1345(a) through (d) and 43 U.S.C. 1351(a)(3)) provides for the coordination and consultation with the affected State and local governments concerning a DOCD.

4.1.1.3.2. Development and Production Drilling

A development or production well is designed to produce a known hydrocarbon reservoir. Multiple wells are commonly drilled from the same structure. The number of wells per structure varies according to the type of structure used, the prospect size, the drilling/production strategy employed for the development drilling program, and the requirements for resource conservation (avoidance of overproduction and reservoir damage). When an exploration well discovers a hydrocarbon resource, the operator must decide whether or not to complete the well without delay, to delay completion with the rig on station (i.e., conducting additional tests), or to temporarily abandon the well and move the rig offsite. If a decision is made to complete the well, a new stage of activity commences. Completing a well involves the treatment of the formation by fracking, adding stimulating chemicals or agents, and installing the downhole equipment that would allow testing of the formation so that flow rates and parameters can be evaluated over a period of days to weeks. Finally the well is ready to go online and produce the oil or gas resources from the reservoir.

A development or production well is designed to extract a known hydrocarbon reservoir. When an exploration well discovers a hydrocarbon accumulation, the operator must decide whether or not to complete the well without delay, to delay completion with the rig on station so that additional tests may be conducted, or to temporarily abandon the well site and move the rig off station. If an exploration well is clearly a dry hole, the operator usually abandons the well without delay.

Completion is the conversion of an exploratory or development well to a producing well. The process begins with installing the downhole equipment to allow testing of the formation and production of oil or gas from the reservoir. Examples of completion activities include setting and cementing the casing, perforating the casing and surrounding cement, installing production tubing and packers, and gravel-packing the well. Completed wells may be put into production if the operator determines the reservoir economics warrant it and if a pipeline is at hand to transport the resource. Alternatively, the well could be "shut in" to await the development of a pipeline or other distribution system. Well treatments are commonly done as part of the completion process to improve well productivity. Acidizing a reservoir to dissolve cementing agents and improve fluid flow is the most common well treatment in the GOM.

4.1.1.3.3. Production Structures

The MMS has described and characterized suitable deepwater production structures in its deepwater reference document (Regg et al., 2000). It is assumed that some variety or combination of floating and/or subsea production facility would be used for producing hydrocarbon resources in the proposed lease sale area. Production systems suitable for the proposed lease sale area include systems that can be deployed in water depths greater than 1,600 m (5,250 ft), automatically removing from consideration structures that are fixed to the seafloor (**Figure 4-1**).

Suitable proposed lease-sale area structures include the following: (1) floating production systems that are moored to the seafloor, such as tension-leg platforms (TLP), semis, and spars; (2) subsea systems that have all the necessary components to produce and control the well on the seafloor; and (3) floating production, storage and offloading systems (FPSO) that consist of a large drillship and shuttle tankers. In the proposed lease sale area, spars, semisubmersibes, and subsea structures would be installed in both water depths. The TLP's, while suitable to the proposed lease sale area's shallower water depth, are not economically feasible. The FPSO's, while suitable for both water depths in the proposed lease sale area, have not been authorized by MMS for use in the EPA. Those production systems that are suitable to the proposed lease sale area are discussed below.

4.1.1.3.3.1. Types of Production Structures

Semisubmersible

A TLP has a hull with pontoons held in place by tensioned tendons connected to a foundation on the seafloor that is secured by piles driven into the seabed. The tensioned tendons provide a broad depth range of utilization and also limit the TLP's vertical motion and, to a degree, its horizontal motion. At present, TLP's can be used in water depths up to approximately 2,100 m (6,900 ft).

Semisubmersible production structures resemble their drilling rig counterparts and are characterized by a floating hull with pontoons below the waterline and vertical columns to the hull box/deck. The structures keep on station with conventional catenary chains or semi-taut line mooring systems connected to anchors in the seabed. Semisubmersibles having dynamic positioning capability would probably deploy catenary or tensioned mooring lines anchored to the seafloor.

A spar structure is a deep-draft, floating caisson that consists of a large-diameter (27.4 to 36.6 m) cylinder or a cylinder with a lower tubular steel trellis-type component (truss spar) that supports a conventional production deck. The cylinder or hull may be moored via a chain catenary or semi-taut line system connected to 6-20 anchors on the seafloor. Spars are now used in water depths up to 900 m (2,950 ft) and may be used in water depths as great as 3,000 m (9,850 ft) (Regg et al., 2000).

Subsea Production

For some development programs, especially those in deep water, an operator may choose to use a subsea production system (Regg et al., 2000) instead of a floating production structure. A subsea production system comprises various components including templates, production tree (well head), "jumper" pipe connections, manifolds, pipelines, control equipment, and umbilicals. A subsea production system can range from a single-well template with production going to a nearby structure to multiple-well templates producing through a manifold to a pipeline and then to a riser system at a distant production facility, possibly in shallower waters.

Subsea systems rely on a "host" facility for support and well control. Centralized or "host" production facilities in deep water or on the shelf may support several satellite subsea developments. Unlike wells from conventional fixed structures, subsea wells do not have surface facilities directly supporting them during their production phases. A drilling rig must be brought on location to provide surface support to reenter a well for workovers and other types of well maintenance activities. In addition, should the production safety system fail and a blowout result, surface support must be brought on location to regain well control.

Although the use of subsea systems has recently increased as development has moved into deeper water, subsea systems are not new to the GOM. The first subsea production wells in the GOM were installed in the early 1960's. Subsea systems in the GOM are currently used in water depths up to 2,400 m. Operators are contemplating their use out to 3,000 m and beyond.

4.1.1.3.3.2. Bottom Area Disturbance

Structures constructed, emplaced, or anchored on the OCS to facilitate oil and gas exploration, development, and production include drilling rigs (jack-ups, semis, and drillships), production platforms, subsea systems, and pipelines. The emplacement of these structures disturbs some area of the sea bottom (benthos) beneath the structure. If anchors are employed, there are some benthic areas around the structure that are also disturbed. This disturbance includes both physical compaction beneath the structure and the resuspension and settlement of sediments. Jack-up rigs and semisubmersibles are assumed to be used in water depths less than 750 m and would potentially disturb about 1.5 ha (3.7 ac) each. In water depths greater than 750 m, dynamically positioned drillships would be used, with negligible benthic disturbance (except a very small area where the well is drilled). Conventional, fixed platforms installed in water depths less than about 400 m have a predicted disturbance of about 2 ha. At water depths exceeding 400 m, compliant towers, TLP's, spars, and floating production systems (FPS) would be used (**Figure 4-1**). A compliant tower consists of a narrow flexible tower and a piled formation that supports a conventional deck. A compliant tower would disturb the same bottom area—about 2 ha—as a conventional, fixed platform. A TLP consists of a floating structure held in place by tensioned tendons connected to the seafloor by templates secured with piles. A TLP would disturb about 5 ha of bottom area. A spar platform consists of a large-diameter cylinder supporting a conventional deck, three types of risers (production, drilling, and export), and a hull that is moored via a taut catenary system of 6-20 lines anchored to the seafloor. The bottom area disturbed by a spar is dependent on the anchor configuration and could be about 5 ha. A FPS consists of a semisubmersible vessel anchored in place with wire rope and chain. A FPS could disturb about 1.5 ha of sea bottom. Subsea systems, located on the ocean floor, are connected to the surface deck via production risers and would disturb less than 1 ha each. Emplacement of pipelines disturbs about 0.32 ha of seafloor per kilometer of pipeline.

Impacts from bottom disturbance are of concern near sensitive areas such as topographic features; pinnacles; low-relief, live-bottom features; chemosynthetic communities; high-density biological communities in water 400 m or greater; and archaeological sites. Regulations and mitigating measures protect known and unknown, newly discovered sensitive areas from potential impacts resulting from bottom disturbance.

4.1.1.3.3.3. Sediment Displacement

Trenching for pipeline burial affects the seafloor by displacing and/or resuspending seafloor sediments. The MMS's regulations (30 CFR 250.1003(a)(1)) require that pipelines installed in water depths <61 m (<200 ft) be buried to a depth of at least 3 ft below the mudline. Pipeline burial reduces pipeline movement by high currents and storms, protects the pipeline from external damage that could result from anchors and fishing gear, reduces the risk of fishing gear entanglement, as well as minimizing interference with the operations of other users of the OCS. It is predicted that 5,000 m^3 of sediment would be resuspended for each kilometer of pipeline trenched. In addition, pipelines crossing fairways must be buried to a depth of at least 10 ft and to 16 ft if crossing an anchorage area. Pipelines constructed as a result of a proposed action are not projected to be constructed in <61 m (<200 ft) or cross a fairway or anchorage area; therefore, no pipeline burials are projected as a result of a proposed action.

Sediment displacement also occurs as a result of the removal of pipelines. It is projected that the number of pipeline removals (or relocations) would increase Gulfwide as the existing pipeline infrastructure ages. For each kilometer of pipeline removed in water depths <61 m (<200 ft), approximately 5,000 m^3 of sediment could be resuspended.

Pipelines projected to be installed as a result of a proposed action would be in water depths >500 m, where DP lay barges would be used. Anchoring would not be required.

Displaced sediments are those that have been physically moved "in bulk." Displaced sediments would cover or bury an area of the seafloor, while resuspended sediments would cause an increase in turbidity of the adjacent water column. Resuspended sediments eventually settle, covering the surrounding seafloor. Resuspended sediments may include entrained heavy metals or hydrocarbons.

Proposed Action Scenario: It is expected that pipelines from proposed action facilities would connect to existing or proposed pipelines near the proposed lease sale area. Because of the projected water depth in which the proposed pipelines would be installed, the scenario assumes no anchoring due to DP lay barges, and no burying.

Gulfwide OCS Program Scenario: From 2003 to 2042, 9,800-24,374 km of pipeline are projected to be constructed in <61 m (<200 ft) as a result of the Gulfwide OCS Program (**Table 4-3**).

4.1.1.3.4. Infrastructure Presence

Hydrocarbon resources cannot be located or developed without physically encountering and penetrating the formations that hold the resource. A drill bit must penetrate structures and rocks that hold promise for containing resources of oil and gas. Drilling rigs, vessels, platforms, machinery, and equipment are necessary to drill to great depths, and to lift, process and transport resource. For this activity to occur, the presence of these facilities hardware in the OCS environment is required. There are limited opportunities to mitigate or modify the presence of these surface and subsurface structures and still have them carry out their designed functions.

4.1.1.3.4.1. Anchoring

In the proposed lease sale area, drilling activities may or may not require anchoring, while production structures would be anchored to the seafloor. In contrast to shallower water, pipeline lay barges and service vessels would not anchor.

Semisubmersibles and/or drillships may be used to drill the 30-40 exploration and delineation wells projected as a result of a proposed action. To remain in place, semisubmersibles would either be anchored or DP. Even some DP semis may anchor. Drillships would use DP systems to remain in place and not anchor.

Anchored drilling activities or production structures (2 projected as a result of a proposed action) would require anchor-handling vessels. These vessels would position and emplace each anchor.

Anchoring systems can be catenary, semi-taut, or taut. The scope of traditional, catenary anchors is 5-7 times the water depth. Taut leg-mooring systems have begun to be used in deep water and reduce the anchor footprint on the seafloor. Regardless of the anchoring system used, a site-specific, environmental assessment of impacts from anchoring would be conducted by MMS for each exploration and development plan received.

Pipelines, projected to be installed as a result of a proposed action, would be in water depths greater than 500 m, where DP lay barges would be used rather than anchoring. In the deeper waters of the proposed lease sale area, service vessels would likely be DP vessels. However, in the shallower waters of the proposed lease sale area, mooring buoys may be used.

4.1.1.3.4.2. Space-Use Conflicts

During OCS operations, the areas occupied by seismic vessels, structures, anchor cables, and safety zones are unavailable to commercial fishermen. Usually, fishermen are precluded from a very small area for several days during active seismic surveying. Virtually all commercial trawl fishing in the GOM is performed in water depth less than 200 m (Louisiana Dept. of Wildlife and Fisheries, 1992). None of the blocks in the proposed action area are in water depths shallower than 1,600 m.

Longline fishing is performed in water depths greater than 100 m and usually beyond 300 m. All surface longlining is prohibited in the northern DeSoto Canyon area (designated as a swordfish nursery area by NOAA Fisheries). In the EPA, the closure area encompasses 160 blocks within the proposed lease sale area. Longline fishing would also probably be precluded from blocks for miles around the closure area because of the great length of typical longline sets and time required for their retrieval.

The scenario assumes exploratory drilling rigs spend 42 days on-site, which would be a short-term interference to commercial fishing. The proposed lease sale area ranges in depth from 1,600 to 3,000 m. This is beyond the range of typical commercial trawling. Even though production structures in deeper water are larger and individually would take up more space, there would be fewer of them compared to the great numbers of bottom-founded platforms in shallower water depths in other parts of the GOM. Factoring in navigational safety zones, deepwater structures would require 7-20 ha of space. Factoring in various configurations of navigational safety zones, deepwater facilities may request up to a 500-m radius safety zone or approximately 95 ha of space depending on the size of the surface structure (USCG regulations, 33 CFR 1, Part 147.15). However, existing Coast Guard-administered 500-m safety zones do not apply to vessels under 100 ft in length and would therefore have no impact on the vast majority of commercial or recreational fishing vessels. The issue of security zones, which could be implemented to protect significant manned structures from a directed threat, is under review but can be imposed at any time by Executive Order under the Ports and Waterways Safety Act for Antiterrorism. Production structures in all water depths have a life expectancy of 20-30 years. The MMS data indicate that the total area lost to commercial fishing due to the presence of production platforms has historically been and would continue to be less than 1 percent of the total area available.

Proposed Action Scenario: Only 40 ha (2 structures @ up to 20 ha) would be lost to commercial fishing as a result of a proposed action. This is approximately 0.00002 percent of the total area available in the proposed lease sale area (about 600,000 ha). Considering that virtually all trawling occurs in water depths of less than 200 m, essentially no trawling area would be lost due to a proposed action. Longlining is only permitted by Federal regulation in 96 blocks south of 28 °N. latitude and would be further limited due to the proximity of the closed area.

Gulfwide OCS Program Scenario: Total OCS EPA production structure installation has been estimated through the year 2042. Total activity in the EPA is estimated as 5-9 installed production structures between 2003 and 2042. As identified oil and gas fields are developed and fewer new reservoirs are located, the overall annual rate of platform and structure installation would decrease. Platform removal rates are assumed to increase as mature fields are depleted. The trend of increased area lost to commercial fishing would be reversed over time as the rate of platform removal exceeds the rate of platform installation. It is assumed that the total area lost to commercial fishing due to the presence of OCS production platforms in the EPA would continue to be less than 0.1 percent of the total area available to commercial fishing with little or no impact to trawling or longlining activities because of water depth and other Federal commercial fishing restrictions.

4.1.1.3.4.3. Aesthetic Interference

The factors that could adversely affect the aesthetics of the coastline are oil spills and residue, tarballs, trash and debris, noise, pollution, increased vessel and air traffic, and the presence of drilling and production platforms visible from land. Oil spills, oil residue from tankers cleaning their holding tanks, and tarballs could affect beaches, wetlands, and coastal residences. Increased vessel and air traffic may result in additional noise or in oil and chemical pollution of water in port and out to sea. The potential visibility of fixed structures in local GOM waters is worrisome for local chambers of commerce and tourist organizations. In a study conducted by the Geological Survey of Alabama (GSA) in 1998, several facets of the visibility of offshore structures were analyzed. The GSA earth scientists found that visibility is dictated not only by size and location of the structures and curvature of the Earth but also by atmospheric conditions. Social scientists added factors, such as the viewer's elevation (ground level, in a 2-story house, or in a 30-story condominium) and the viewer's expectations and perceptions. The size of an offshore structure depends on the reservoir being tapped, characteristics of the well-stream fluid, and the type of processing needed to treat the hydrocarbons. Location reflects the geology of the reservoir. Optimal location of structures means at or near the surface of the reservoir (GSA, 1998). Atmosphere refers to conditions of weather, air quality, and the presence or absence of fog, rain, smog, and/or winds. The height of the viewer affects their ability to see and distinguish objects several yards or miles away. Perceptions often dictate what people expect to see and, hence, what they do see.

To test visibility in as scientific a way as possible, GSA staff worked with members of the Offshore Operators Committee. They took a series of photographs on one day in October 1997, from a helicopter hovering at 300 ft. They used the same camera, lens, shutter speed, and f-stop setting. The subjects of the photos were four different types of structures usually found in both State and Federal waters offshore Alabama. The structures ranged in height from 60 to 70 ft; they varied in size from 120 ft by 205 ft to 40 ft by 90 ft with the smallest being 50 ft by 80 ft. The tallest and widest structures, i.e., those showing the most surface in the viewscape, were visible at up to 5 mi from shore. The shorter and the smaller the structure, the less visible at 5 mi; the smallest could barely be seen at 3 mi from shore. According to this study, no structure located more than 10 mi offshore would be visible (GSA, 1998). The proposed lease sale area is 70 mi from Louisiana, 98 mi from Mississippi, 93 mi from Alabama, and 100 mi from Florida.

Additional impact producing factors associated with offshore oil and gas activities are oil spills and trash and debris. These are the most widely recognized as major threats to the aesthetics of coastal lands, especially recreational beaches. These factors, individually or collectively, may adversely affect the fishing industry, resort use, and the number and value of recreational beach visits. The effects of an oil spill on the aesthetics of the coastline depend on factors such as season, extent of pollution, beach type and location, condition and type of oil washing ashore, tidal action, and cleanup methods (if any).

4.1.1.3.4.4. Bottom Debris

Bottom debris is defined as material resting on the seabed (such as cable, tools, pipe, drums, anchors, and structural parts of platforms, as well as objects made of plastic, aluminum, wood, etc.) that are accidentally lost (e.g., during hurricanes) or tossed overboard from facilities. The maximum quantity of bottom debris per operation is estimated to be several tons. **Chapter 4.1.1.11.** describes the requirements and guidelines for removing bottom debris and gear after structure decommissioning and removal operations. Up to a several tons of bottom debris are expected to result from activities associated with a proposed action.

4.1.1.3.5. Workovers and Abandonments

Completed and producing wells require periodic reentry that is designed to maintain or restore a desired flow rate. These procedures are referred to as a well "workover." Workover operations are also carried out to evaluate or reevaluate a geologic formation or reservoir, or to permanently abandon a well. Examples of workover operations are acidizing the perforated interval in the casing, plugging back, squeezing cement, milling out cement, jetting the well in with coiled tubing and nitrogen, and setting positive plugs to isolate hydrocarbon zones. Workovers on subsea completions require that a rig be moved on location to provide surface support. Workovers can take from a few days to several months to complete, with an average of about 5-15 days. Historical data suggest that each producing well averages one workover or other well operation/treatment about every 4 years (USEPA, 1993a and b). Current oil-field practices include preemptive procedures or treatments that reduce the number of workovers required for each well. The MMS's projections suggest that a producing well may expect to have 6-9 workovers or other well activities during its lifetime.

There are two types of well abandonment operations–temporary and permanent. An operator may temporarily abandon a well to (1) allow detailed analyses or additional delineation wells while deciding if a discovery is economically viable, (2) save the wellbore for a future sidetrack to a new geologic bottom-hole location, or (3) wait on design or construction of special production equipment or facilities. The operator must meet specific requirements to temporarily abandon a well (30 CFR 250.703). Permanent abandonment operations are undertaken when a well bore is of no further use to the operator (i.e., the well is a dry hole or the well's producible hydrocarbon resources have been depleted). During permanent abandonment operations, equipment is removed from the well, and specific intervals in the well that have hydrocarbon shows are plugged with cement.

Proposed Action Scenario: **Table 4-2** shows there are 80-111 workovers projected as a result of a proposed action. The projected number of workovers is a function of producing wells, which includes completions expected to occur on approximately 85 percent of the development wells drilled. One permanent abandonment operation per well is projected.

Gulfwide OCS Program Scenario: **Table 4-3** shows there are 148,300-167,000 workovers projected Gulfwide as a result of the OCS Program. Of these, 0.3-0.5 percent would be in the EPA, 77-76 percent in the CPA, and 22-24 percent in the WPA. The projected number of workovers is a function of producing wells, which includes completions expected to occur on approximately 85 percent of the development wells drilled. One permanent abandonment operation per well is projected.

4.1.1.4. Operational Waste Discharged Offshore

The primary operational waste discharges generated during offshore oil and gas exploration and development are drilling fluids, drill cuttings, produced water, deck drainage, sanitary wastes, and domestic wastes. During production activities, additional waste streams include produced sand and well treatment, workover, and completion (TWC) fluids. Minor additional discharges occur from numerous sources; these discharges may include desalination unit discharges, blowout preventer fluids, boiler blowdown discharges, excess cement slurry, and uncontaminated freshwater and saltwater.

The USEPA, through NPDES permits issued by the USEPA Region that has jurisdictional oversight, regulates all waste streams generated from offshore oil and gas activities. The USEPA published the most recent effluent guidelines for OCS oil and gas extraction point-source category in 1993 (58 FR 12454). On January 22, 2001 (66 FR 6850), the USEPA guidelines were amended to address the discharge of SBF and other nonaqueous drilling fluids.

The USEPA Region 4 has jurisdiction over all of the EPA and the part of the CPA that is off the coasts of Alabama and Mississippi. The proposed lease sale area is within the jurisdiction of Region 4. The USEPA Region 6 has jurisdiction over the rest of the CPA and all of the WPA. Each USEPA Region has issued general permits for discharges that incorporate the 1993 effluent guidelines as a minimum. Vessels and pipelines servicing the proposed lease sale area are likely to traverse USEPA Region 6. The USEPA Region 4's current general permit was issued on October 16, 1998 (63 FR 55718) and modified on March 14, 2001 (66 FR 14988). It will expire on October 31, 2003. Region 4 has not revised its general permit to incorporate the new guidelines for SBF and other nonaqueous-based drilling fluids. The USEPA Region 6's general permit was issued on November 2, 1998 (63 FR 58722) and modified on April 19, 1999 (64 FR 19156). It was modified again on February 16, 2002, to incorporate the new SBF guidelines and will expire on November 3, 2003. The USEPA Region 6's modification authorizes the discharge of drill cuttings produced using SBF and other nonaqueous-based drilling fluids and wastewater used to pressure test existing piping and pipelines. The USEPA Region 4 may allow wastewater discharges within 1,000 m of Areas of Biological Concern after a comprehensive individual permit review but not for facilities desiring coverage by the General Permit.

4.1.1.4.1. Drilling Muds and Cuttings

The largest amount of discharges from drilling operations are drilling fluids (also known as drilling muds) and cuttings. Drilling fluids are used in rotary drilling to remove cuttings from beneath the bit, to control well pressure, to cool and lubricate the drill string, and to seal the well. Drill cuttings are the fragments of rock generated during drilling and carried to the surface with the drilling fluid.

The composition of drilling fluids is complex. The bulk of the mud consists of clays, barite, and a base fluid, which can be fresh or salt water, mineral or diesel oil, or any of a number of synthetic oils. Drilling fluids and muds used on the OCS are divided into three categories: water based, oil based, and synthetic based. Numerous chemicals are added to improve the performance of the drilling fluid (Boehm et al., 2001).

Water-based drilling fluids (WBF) have been used for decades to aid drilling on the continental shelf. The WBF may have up to 3 percent by volume diesel oil or mineral oil added for lubricity. The discharge of WBF and cuttings associated with WBF is allowed everywhere on the OCS under the general NPDES permits issued by USEPA Regions 4 and 6, as long as the discharge meets toxicity guidelines. The USEPA (1993a and b) estimated that 12 percent of all drilling fluids and 2 percent of all drill cuttings were brought to shore for treatment and disposal under the previous NPDES general permit criteria.

Discharge of WBF results in increased turbidity in the water column, alteration of sediment characteristics because of coarse material in cuttings, and trace metals. Occasionally, formation may be discharged with the cuttings, adding hydrocarbons to the discharge. In shallow environments, WBF are rapidly dispersed in the water column immediately after discharge and rapidly descend to the seafloor (Neff, 1987). In deep waters, fluids dispersed near the water surface would disperse over a wider area than fluids dispersed in shallow waters.

Oil-based drilling fluids (OBF) are occasionally used for directional drilling and in drill-bore sections where additional lubricity is needed. Mineral oil is advantageous because it is less toxic than diesel oil. Studies on the effects of the marine discharge of OBF show that they do not readily disperse in the water column and reach the sediment as clumps. Hydrocarbon concentration and impacts to benthic community diversity and abundance have been observed within 200 m of the drill site with diminishing impacts measured to a distance of 2,000 m (Neff, 1987). Diesel OBF contains light aromatics such as benzene, toluene, and xylene. All OBF and associated cuttings must be transported to shore for recycling or disposal unless reinjected. All OBF are likely to be replaced by SBF in deepwater drilling because of the many advantageous features of SBF (Neff et al, 2000).

Since 1992, SBF have been increasingly used, especially in deep water, because they perform better than WBF and OBF. The SBF reduce drilling times and costs incurred from expensive drilling rigs, and are less toxic than OBF. For SBF, the discharge of drilling fluids is prohibited. A recent literature review (Neff et al., 2000) discusses the current knowledge about the fate and effects of SBF discharges on the seabed. Like OBF, SBF do not disperse in the water column and therefore are not expected to adversely affect water quality. They do, however, settle close to the discharge point and affect the local sediments. Unlike OBF, SBF do not contain aromatic compounds and are not toxic. The primary affects are smothering of the benthic community, alteration of sediment grain size, and addition of organic matter which can result in localized anoxia while the SBF degrade. Different formulations of SBF result in base fluids that degrade at different rates, thus affecting the impact. Esters and olefins are the most rapidly biodegraded SBF's. Bioaccumulation tests indicate that SBF and their degradation products should not bioaccumulate. It is assumed that discharged SBF's adhered to cuttings degrade within 2-3 years after discharge (Neff et al., 2000). However, colder temperatures at greater depths could retard biodegradation.

Under USEPA Region 4's general NPDES permit, cuttings wetted with SBF cannot be discharged and must be transported to onshore disposal or obtain coverage under an individual NPDES permit. The USEPA Region 4 expects to readdress SBF guidelines under a new permit that would replace the current permit once it expires on October 31, 2003. At present, no individual permit which includes the discharge of SBF wetted cuttings has been approved by USEPA Region 4 (Truman, personal communication, 2002).

Table 4-8(a) presents the estimated volumes of water-based and synthetic-based fluids and cuttings generated and discharged per depth from an average well drilled to 2,800 m below the seafloor in the proposed lease sale area. The upper portion of the well would be drilled with WBF while the remainder would be drilled with SBF. For this well the "switchover" from WBF to SBF would occur at approximately 800 m. The upper sections would be drilled with a large diameter bit; progressively smaller drill bits are used with increasing depth. Therefore, the volume of cuttings per interval (length of wellbore) in the upper section of the well would be greater than the volume generated in the deeper sections.

From July 2002 to February 2003, operators within the proposed lease sale area have submitted eight exploration plans proposing to test deeper geologic horizons. The estimated volumes of WBF and SBF and cuttings generated and discharged per depth are shown in **Table 4-8(b)**. To estimate the drilling discharges from these deeper wells, another generic wellbore design was developed to approximate the quantity of drilling discharges (cuttings and drilling fluid that may adhere to these cuttings) from these wells. This deep well design is similar to the wellbore schematic seen in **Figure 4-2** (described in **Chapter 4.1.1.2.3.**, Exploration and Delineation Drilling), except additional casing strings and drilling liners have been included in the wellbore. The casing points for the various strings have been adjusted to reflect possible geologic conditions that may be encountered with the deep wellbores. While the generic wellbore in **Figure 4.2** had a total depth of approximately 2,800 m (9,150 ft), the deep well design extends the drilling depth to approximately 5,900 m (19,400 ft). For the deep well design, the "switchover" from a WBF to a SBF is expected to occur at approximately the 914-m (3,000-ft) depth. Estimates of cuttings for the deep well design include "wash out" volumes for the wellbore that are similar to those used in the original generic wellbore (drilling intervals from 0 to 914 m (0-3,000 ft) at 20-40% and 5-15% from 914 m (3,000 ft) to total depth of the well measured from the seafloor).

Deep wells drilled during the development phase of operation on a project may not include all of the casings used in the exploration wells because operators gain geologic information from the exploratory wells and adjust their development drilling programs accordingly.

These values are estimates for informational purposes only. Well depths in the proposed lease sale area are expected to extend as deep as 6,000-7,700 m below the seafloor. The estimated volume of WBF and cuttings generated would be discharged according to NPDES permit limitations. The estimated volume of SBF generated is the amount of the base fluid adhering to cuttings. Discharge of SBF and SBF adhered to cuttings is currently prohibited. The SBF is rented by the operator. At the end of drilling, the SBF is returned to the mud company for recycling. Internal olefins are the most prevalent base fluid for the SBF used in deepwater drilling in the GOM. However, some operators have used polyalpha olefins, esters, or their own proprietary blend as the base fluid. Since OBF are used under special circumstances and may be replaced with SBF, estimates of the amount of OBF muds and cuttings are not possible.

Drilling discharges of muds and cuttings are regulated by USEPA through a NPDES permit. Barite, barium sulfate, is a major component of all drilling fluid types (WBF, OBF, and SBF). Mercury and other trace metals are naturally occurring impurities in barite. Since 1993, USEPA has required concentrations of mercury and cadmium to be less than or equal to 1 ppm and 3 ppm, respectively, in the stock barite used to make drilling muds. Through mercury and cadmium regulation, USEPA can also control levels of other trace metals in barite. This reduces the addition of mercury to values similar to the concentration of mercury found in marine sediments throughout the GOM (Avanti Corporation, 1993a and b; USEPA, 1993a and b). Trace metals including mercury are of concern because of the potential for a toxic effect or bioaccumulation in some marine organisms. Mercury is of particular concern because it can be bioaccumulated in aquatic organisms. Concentrations of total mercury in uncontaminated estuarine and marine sediments generally are 0.2 μg/g dry weight or lower. Surface sediments collected 20-2,000 m away from four oil production platforms in the northwestern GOM contained 0.044-0.12 μg/g total mercury. These amounts are essentially background concentrations for mercury in surficial sediments on the GOM OCS (Neff, 2002).

Atmospheric mercury deposition is believed to be the main source of anthropogenic mercury inputs into the marine environment. Mercury in barite has been suggested as a secondary source in the GOM. Trace mercury in barite deposits is present predominantly as mercuric sulfate and mercuric sulfide (Trefrey, 1998). Barite is nearly insoluble in seawater, thus trapping mercury and other trace metals in the barite grains. Therefore, unless the mercuric sulfide in the barite can be microbially methylated, this source of mercury is relatively unavailable for uptake into the marine food web.

In May 2002, sediment samples were collected at six offshore drilling sites for total mercury and methylmercury analysis (Trefrey, 2002). The results show more total mercury in sediment samples near the drilling site and drill cuttings. However, methylmercury is not elevated in sediment samples near or far from the drill site. Thus, the study indicates that mercury in barite used in drilling muds offshore is not contributing to elevated methylmercury. Additional studies are planned to further evaluate the potential for conversion of inorganic mercury to methylmercury.

Research conducted by Neff et al. (1989) showed no uptake of mercury in winter flounder exposed to barite-amended sediments. Inorganic mercury is converted to methylmercury in the environment. Methylmercury bioaccumulates through the food chain. It is bioaccumulated in the muscle of marine animals. Elevated levels of methylmercury have been found in top predatory fish and marine mammals (USEPA, 1997).

4.1.1.4.2. Produced Waters

Produced water is brought up from the hydrocarbon-bearing strata along with produced oil and gas. This waste stream can include formation water; injection water; well treatment, completion, and workover compounds added downhole; and compounds used during the oil/water separation process. Formation water, also called connate water or fossil water, originates in the permeable sedimentary rock strata and is brought up to the surface commingled with the oil and gas. Injection water is used to enhance oil production and in secondary oil recovery.

Produced water contains chemicals, which dissolved into the water from the geological formation where the water was stored. Produced water contains inorganic and organic chemicals and radionuclides (226Ra and 228Ra). The composition of the discharge can vary greatly in the amounts of organic and inorganic compounds.

The USEPA general permits allow the discharge of produced water on the OCS provided the discharge meets discharge criteria. Oil and grease cannot exceed 42 mg/l daily maximum or 29 mg/l monthly average. Region 4 does not allow any discharge within 1,000 m of an area of biological concern. The discharge must also be tested for toxicity on a monthly basis.

Estimates of the volume of produced water generated per well are difficult because the percent water is a site-specific phenomenon. Usually, produced-water volumes are small during the initial production phase and increase as the formation approaches hydrocarbon depletion. Produced-water volumes range from 2 to 150,000 bbl/day (USEPA, 1993a and b). In some cases, a centralized platform is used to process water from several surrounding platforms. Some of the produced water may be reinjected into the well. Reinjection occurs when the produced water does not meet discharge criteria or when the water is used as part of operations.

The MMS maintains records of the volume of produced water discharged on the OCS. The information, for the years 1996-2000, is summarized in **Table 4-9**. The annual volume ranges from 457 MMbbl in 1996 to 586 MMbbl of produced water discharged overboard during 2000. As of this EIS's publication, a full year of data for 2001 was not available. The 1996-2000 data shows that leases in water depths greater than 1,000 m have a maximum annual average per well of 60,000 bbl of produced water discharged overboard. The majority of produced water is on the continental shelf off the coast of Louisiana. Very little water is produced off the coast of Texas because activity in this area is primarily gas fields. For deepwater operations, new technologies are being developed that may discharge produced water at the seafloor or at "minimal surface structures" before the production stream is transported by pipeline to the host production facility.

Proposed Action Scenario: An average annual rate of 1-2 MMbbl of proposed water is projected to be discharged overboard from 16 to 22 producing wells as a result of a proposed action. During the years of peak activity, 2-3 MMbbl per year of produced water are projected from a proposed action.

Gulfwide OCS Program Scenario: It is estimated that 532 MMbbl per year of produced water would be discharged overboard from OCS activities.

4.1.1.4.3. Well Treatment, Workover, and Completion Fluids

Wells are drilled using a base fluid and a combination of other chemicals to aid in the drilling process. Fluids (drilling muds) present in the borehole can damage the geologic formation in the producing zone. Completion fluids are used to displace the drilling fluid and protect formation permeability. “Clear” fluids consist of brines made from seawater mixed with calcium chloride, calcium bromide, and/or zinc bromide. These salts can be adjusted to increase or decrease the density of the brine. Additives, such as defoamers and corrosion inhibitors, are used to reduce problems associated with the completion fluids. Recovered completion fluids can be recycled for reuse.

Workover fluids are used to maintain or improve existing well conditions and production rates. Six to nine workovers are projected per producing well over their lifetime. Workover operations include casing and subsurface equipment repairs, re-perforation, acidizing, and fracturing stimulation. During some of the workover operations, the producing formation may be exposed, in which case fluids like the aforementioned completion fluids are used. In other cases, such as acidizing and fracturing (also considered stimulation), hydrochloric (HCl) and other acids are used. Both procedures are used to increase the permeability of the formation. The acids dissolve limestone, sandstone, and other deposits. Because of the corrosive nature of acids, particularly when hot, corrosion inhibitors are added. Since the fluids are altered with use, they are not recovered and recycled; however, these products may be mixed with the produced water.

Production treatment fluids are chemicals applied during the oil and gas extraction process. Production chemicals are used to dehydrate produced oil or treat the associated produced water for reuse or disposal. A wide variety of chemicals are used including corrosion and scale inhibitors, bactericides, paraffin solvents, demulsifiers, foamers, defoamers, and water treatment chemicals (Boehm et al., 2001). Some of the production chemicals mix with the production stream and are transported to shore with the product. Other chemicals mix with the produced water. Most produced water cannot be discharged without some chemical treatment. Even water that is reinjected downhole must be cleaned to protect equipment. The types and volumes of chemicals that are used changes during the life of the well. In the early stages, defoamers are used. In the later stages, when more water than oil is produced, demulsifiers and water-treatment chemicals are used more extensively.

The USEPA Region 4, under the NPDES general permit (GMG280000, 63 FR 55718), allows the discharge of well-treatment, completion, and workover fluids, which meet the specified guidelines. Additives containing priority pollutants must be monitored. Some well treatment, workover, and completion chemicals are discharged with the drilling muds and cuttings or with the produced-water streams. Both must meet the general toxicity guidelines in the NPDES general permit. Discharge and monitoring records must be kept.

4.1.1.4.4. Production Solids and Equipment

As defined by USEPA in the discharge guidelines (58 FR 12454, 66 FR 6849), produced sands are slurried particles, which surface from hydraulic fracturing, and the accumulated formation sands and other particles including scale, which is generated during production. This waste stream also includes sludges generated in the produced-water treatment system, such as tank bottoms from oil/water separators and solids removed in filtration. The guidelines do not permit the discharge of produced sand, which must be transported to shore and disposed of as nonhazardous oil-field waste according to State regulations. Estimates of total produced sand expected from a platform are from 0 to 35 bbl/day according to USEPA (1993a and b). A variety of solid wastes are generated including construction/demolition debris, garbage, and industrial solid waste. No equipment or solid waste may be disposed of in marine waters.

4.1.1.4.5. Deck Drainage

Deck drainage includes all wastewater resulting from platform washings, deck washings, rainwater, and runoff from curbs, gutters, and drains including drip pans and work areas. The USEPA general guidelines for deck drainage require that no free oil be discharged, as determined by visual sheen.

The quantities of deck drainage vary greatly depending on the size and location of the facility. An analysis of 950 GOM platforms during 1982-1983 determined that deck drainage averages 50 bbl/day/platform (USEPA, 1993a and b). The deck drainage is collected, the oil is separated, and the water is discharged to the sea.

4.1.1.4.6. Treated Domestic and Sanitary Wastes

Domestic wastes originate from sinks, showers, laundries, and galleys. Sanitary wastes originate from toilets. For domestic waste, no solids or foam may be discharged. In sanitary waste, floating solids are prohibited. Facilities with 10 or more people must meet and maintain the requirement of total residual chlorine greater than 1 mg/l. There is an exception in the USEPA Region 4 general permit for the use of marine sanitation devices (MSD).

In general, a typical manned platform would discharge 35 gallons/person/day of treated sanitary wastes and 50-100 gallons/person/day of domestic wastes (USEPA, 1993a and b). It is assumed that these discharges are rapidly diluted and dispersed; therefore, no analysis of the impacts would be performed for a proposed action.

4.1.1.4.7. Minor Discharges

Minor discharges include all other discharges not already discussed that may result during oil and gas operations. Minor or miscellaneous wastes include desalination unit discharge, blowout preventer fluid, boiler blowdown, excess cement slurry, and uncontaminated freshwater and saltwater. In all cases, the USEPA Region 4 general permit states that no free oil shall be discharged with the waste. Unmanned facilities may discharge uncontaminated water through an automatic purge system without monitoring for free oil. The discharge of freshwater or seawater that has been treated with chemicals is permitted providing that the prescribed discharge criteria are met. No projections of volumes or contaminant levels of minor discharges are made for a proposed action because the impacts are considered negligible.

4.1.1.4.8. Vessel Operational Wastes

The USCG defines an offshore supply vessel as a vessel propelled by machinery other than steam that is of 15 gross tons and less than 500 gross tons (46 CFR 90.10-40). Operational waste generated from supply vessels that support oil and gas operations include bilge and ballast waters, trash and debris, and sanitary and domestic wastes.

Bilge water is water that collects in the lower part of a ship. The bilge water is often contaminated by oil that leaks from the machinery within the vessel. The discharge of any oil or oily mixtures is prohibited under 33 CFR 151.10; however, discharges may occur in waters greater than 12 nmi if the oil concentration is less than 100 ppm. Discharges may occur within 12 nmi if the concentration is less than 15 ppm.

Ballast water is used to maintain stability of the vessel and may be pumped from coastal or marine waters. Generally, the ballast water is pumped into and out of separate compartments and is not usually contaminated with oil; however, the same discharge criteria apply as for bilge water (33 CFR 151.10).

The discharge of trash and debris is prohibited (33 CFR 151.51-77) unless it is passed through a comminutor and can pass through a 25-mm mesh screen. All other trash and debris must be returned to shore for proper disposal with municipal and solid waste facilities. All vessels with toilet facilities must have a MSD that complies with 40 CFR 140 and 33 CFR 149. Vessels complying with 33 CFR 159 are not subject to State and local MSD requirements. However, a State may prohibit the discharge of all sewage within any or all of its waters. Domestic waste consists of all types of wastes generated in the living spaces on board a ship including gray water that is generated from dishwasher, shower, laundry, bath and washbasin drains. State and local governments regulate gray water from vessels. Gray water is not federally regulated in the GOM.

4.1.1.4.9. Assumptions About Future OCS Operational Wastes

As oil exploration and production expands into deeper water, some characteristics of waste (type, volume, and discharge location) would change. The WBF and SBF would be the most commonly used drilling fluids. The use of SBF would increase and replace the use of OBF in most deepwater situations. The USEPA Region 6 has modified its general permit to allow the discharge of cuttings wetted with SBF.

The USEPA Region 4 (under which the proposed lease sale area falls) is expected to do so in 2003. The discharge of cuttings wetted with SBF would result in fewer cuttings brought to shore for disposal. New technologies in deep water may result in operational waste discharged at the seafloor. The movement into deep water would result in fewer total platforms but greater volumes of discharges at each platform.

4.1.1.5. Trash and Debris

The OCS oil and gas operations generate trash and debris materials made of paper, plastic, wood, glass, and metal. Most of this trash is associated with galley and offshore food service operations and with operational supplies such as shipping pallets, containers used for drilling muds and chemical additives (sacks, drums, and buckets), and protective coverings used on mud sacks and drilling pipes (shrink wrap and pipe-thread protectors). Some personal items, such as hardhats and personal flotation devices, are accidentally lost overboard from time to time. Generally, galley, operational, and household trash is collected and stored on the lower deck near the loading dock in large receptacles resembling dumpsters. These large containers are generally covered with netting to avoid loss and are returned to shore by service vessels for disposal in landfills. Drilling operations require the most supplies, equipment, and personnel, and therefore, generate more solid trash than production operations.

The MMS regulations, USEPA's NPDES general permit, and USCG regulations implementing MARPOL 73/78 Annex V prohibit the disposal of any trash and debris into the marine environment. Victual matter or organic food debris may be ground up into small pieces and disposed of overboard from structures located more than 20 km from shore.

Over the last several years, companies have employed trash and debris reduction and improved handling practices to reduce the amount of offshore trash that could potentially be lost into the marine environment. Improved trash management practices, such as substituting paper and ceramic cups and dishes for those made of styrofoam, recycling offshore trash, and transporting and storing supplies and materials in bulk containers when feasible, are commonplace and have resulted in a marked decline in accidental loss of trash and debris.

4.1.1.6. Air Emissions

Any OCS activity that uses equipment that burns a fuel, transports and/or transfers hydrocarbons, or results in accidental releases of petroleum hydrocarbons or chemicals would cause emission of air pollutants. Some of these pollutants are precursors to ozone, which is formed by complex photochemical reactions in the atmosphere.

The criteria pollutants considered here are NO_2, CO, SO_x, volatile organic compounds (VOC), and PM_{10}. Criteria pollutant emissions from OCS platforms and drilling operations are estimated using the emission rates presented in **Table 4-10**. These emission rates are derived from a 1991-1992 MMS inventory of offshore OCS structures (Steiner et al., 1994) that takes into account deepwater activities.

Tables 4-10 and 4-11 present average annual emission rates from OCS infrastructure in the GOM and the EPA, respectively. Emissions of air pollutants during loading, storage, and transportation of crude oil and gas are calculated using the methodology and emission factors presented in USEPA publication AP-42 of 1985 with supplements A, B, and C. Helicopter emissions are calculated using the methodology presented in the previous reference.

Flaring is the venting and/or burning of natural gas from a specially designed boom. Flaring systems are also used to vent gas during well testing or during repair/installation of production equipment. The MMS operating regulations provide for the flaring or venting of natural gas for a limited time and volume upon approval by MMS. Flaring may occur for short periods (typically 2-14 days) as part of unloading/testing operations necessary to remove potentially damaging completion fluids from the wellbore, to provide sufficient reservoir data for the operator to evaluate a reservoir and development options, and in emergency situations. Emissions from flaring are included in the emissions tables and in the modeling analysis (since platform emissions include flaring along with all other sources).

4.1.1.7. Noise

Noise associated with OCS oil and gas development results from seismic surveys, the operation of fixed structures such as offshore platforms and drilling rigs, and helicopter and service-vessel traffic. Noise generated from these activities can be transmitted through both air and water, and may be extended or transient. Offshore drilling and production involves various activities that produce a composite underwater noise field. The intensity level and frequency of the noise emissions are highly variable, both between and among the various industry sources. Noise from proposed OCS activities may affect resources near the activities. Whether a sound is or is not detected by marine organisms would depend both on the acoustic properties of the source (spectral characteristics, intensity, and transmission patterns) and sensitivity of the hearing system in the marine organism. Extreme levels of noise can cause physical damage or death to an exposed animal; intense levels can damage hearing; and loud or novel sounds may induce disruptive behavior or other responses of lesser importance.

When the MMPA was enacted in 1972, the concept that underwater sounds of human origin could adversely affect marine mammals was not considered or recognized (MMC, 2002). Concern on the effects of underwater noise on marine mammals and the increasing levels of manmade noise introduced into the world's oceans has since become a major environmental issue (Jasny, 1999). It is generally recognized that commercial shipping is a dominant component of the ambient, low-frequency background noise in modern world oceans (Gordon and Moscrop, 1996) and that OCS-related, service-vessel traffic would contribute to this. For the GOM, that contribution to existing shipping noise is likely insignificant (USDOI, MMS, in preparation). Another sound source more specific to OCS operations originates from seismic operations. Airguns produce an intense but highly localized sound energy and represent a noise source of possible concern. The MMS has almost completed a programmatic EA on G&G permit activities in the GOM (USDOI, MMS, in preparation). The EA includes a detailed description of the seismic surveying technologies, energy output, and operations; these descriptions are incorporated here by reference.

Marine seismic surveys direct a low-frequency energy wave (generated by an airgun array) into the ocean floor and record the reflected energy waves' strength and return arrival time. The pattern of reflected waves, recorded by a series of hydrophones embedded in cables towed by the seismic vessel (streamers) or ocean bottom cables (OBC) placed on the ocean floor, can be used to "map" subsurface layers and features. Seismic surveys can be used to check for foundation stability, detect groundwater, locate mineral deposits (coal), and search for oil and gas. Most commercial seismic surveying is carried out for the energy sector (Gulland and Walker, 1998). Two general types of seismic surveys are conducted in the GOM relative to oil and gas operations. High-resolution site surveys collect data up to 1 km deep through bottom sediments and are used for initial site evaluation for potential structures as well as for exploration. This involves a small vessel and usually a single airgun source and is also usually restricted to small areas, most often a single lease site.

Seismic exploration and development surveys are often conducted over large survey areas (multiple leases and blocks) and obtain information on geological formations to several thousands meters below the ocean floor. For "2D" surveys, a single streamer (hydrophones) is towed behind the survey vessel, together with a single source (airguns) (Gulland and Walker, 1998). Seismic vessels generally operate at low hull speeds (<10 knots) and follow a systematic pattern during a survey, typically a simple grid pattern for 2D work with lines no closer than half a kilometer.

In simplistic terms, "3D" surveys collect a very large number of 2D slices, perhaps with line separations of only 25-30 m. A 3D survey may take months to complete and involves a precise definition of the survey area and transects, usually a series of passes to cover a given survey area (Caldwell, 2001). In 1984, industry operated the first twin streamers. By 1990, industry achieved a single vessel towing two airgun sources and six streamers. Industry continues to increase the capability of a single vessel, now using eight streamer/dual source configurations and multi-vessel operations (Gulland and Walker, 1998). For exploration surveys, 3D methods represent a substantial improvement in resolution and useful information relative to 2D methods. Many areas in the GOM previously surveyed using 2D have been or would be surveyed using 3D. It can be assumed that for new deepwater areas, 3D surveys would be the preferred method for seismic exploration, until and if better technology evolves.

A typical 3D airgun array would involve 15-30 individual guns. The firing times of the guns are staggered by milliseconds (tuned) in an effort to make the farfield noise pulse as coherent as possible. In short, the intent of a tuned airgun array is to have it emit a very symmetric packet of energy in a very short amount of time, and with a frequency content that penetrates well into the earth at a particular location (Caldwell, 2001). The noise generated by airguns is intermittent, with pulses generally less than one second in duration, for relatively short survey periods of several days to weeks for 2D work and site surveys (Gales, 1982) and weeks to months for 3D surveys (Gulland and Walker, 1998). Airgun arrays produce noise pulses with very high peak levels. The pulses are a fraction of a second and repeat every 5-15 seconds. In other words, while airgun arrays are by far the strongest sources of underwater noise associated with offshore oil and gas activities, because of the short duration of the pulses, the total energy is limited (Gordon and Moscroup, 1996). This is an important factor when evaluating potential effects on marine animals.

At distances of about 500 m and more (farfield), the array of individual guns would effectively appear to be a single point source (Caldwell, 2001). In the past, sound-energy levels were expected to be less than 200 dB $re^{-1}\mu Pa$-m (standard unit for source levels of underwater sound: 200 decibels, reference pressure 1 micropascal, reference range 1 meter) at distances beyond 90 m from the source (Gales, 1982). Gulland and Walker (1998) state a typical source would output approximately 220 dB $re^{-1}\mu Pa$-m, although the peak-to-peak source level directly below a seismic array can be as high as 262 dB $re^{-1}\mu Pa$-m (Davis et al., 1998b). More recently, it has been estimated a typical 240-dB seismic array would have a 180 dB $re^{-1}\mu Pa$-m level at approximately 225 m from the array (USDOI, MMS, in preparation). The 180 dB $re^{-1}\mu Pa$-m level is an estimate of the threshold of sound energy that may cause hearing damage in cetaceans (U.S. Dept. of the Navy, 2001). Until further studies are completed, NOAA Fisheries continues to use this estimated threshold. It is unclear which measurements of a seismic pulse provide the most helpful indications of its potential impact on marine mammals (Gordon et al., 1998). Gordon et al. speculate that peak broadband pressure and pulse time and duration would be most relevant at short ranges (hearing damage range) while sound intensity in 1/3 octave bands is a more useful measurement at distance (behavioral effects).

Information on drilling noise in the GOM is unavailable to date. From studies mostly in Alaskan waters, drilling operations often produce noise that includes strong tonal components at low frequencies, including infrasonic frequencies in at least some cases. Drillships are apparently noisier than semisubmersibles (Richardson et al., 1995). Sound and vibration paths to the water are through either the air or the risers, in contrast to the direct paths through the hull of a drillship.

Machinery noise generated during the operation of fixed structures can be continuous or transient, and variable in intensity. Underwater noise from fixed structures ranges from about 20 to 40 dB above background levels within a frequency spectrum of 30-300 hertz (Hz) at a distance of 30 m from the source (Gales, 1982). These levels vary with type of platform and water depth. Underwater noise from platforms standing on metal legs would be expected to be relatively weak because of the small surface area in contact with the water and the placement of machinery on decks well above the water.

Aircraft and vessel support may further ensonify broad areas. Noise generated from helicopter and service-vessel traffic is transient in nature and extremely variable in intensity. Helicopter sounds contain dominant tones (resulting from rotors) generally below 500 Hz (Richardson et al., 1995). Helicopters often radiate more sound forward than backward; thus, underwater noise is generally brief in duration, compared with the duration of audibility in the air. In addition to the altitude of the helicopter, water depth and bottom conditions strongly influence propagation and levels of underwater noise from passing aircraft. Lateral propagation of sound is greater in shallow than in deep water. Helicopters, while flying offshore, generally maintain altitudes above 700 ft during transit to and from the working area and an altitude of about 500 ft while between platforms.

Service vessels transmit noise through both air and water. The primary sources of vessel noise are propeller cavitation, propeller singing, and propulsion; other sources include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake (Richardson et al., 1995). Propeller cavitation is usually the dominant noise source. The intensity of noise from service vessels is roughly related to ship size, laden or not, and speed. Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladen vessels. For a given vessel, relative noise also tends to increase with increased speed. Commercial vessel noise is a dominant component of manmade ambient noise in the ocean (Jasny, 1999). Given the amount of vessel traffic from all sources in the GOM, CSA concludes that the contribution of noise from offshore service vessels is a minor component of the total ambient noise level (USDOI, MMS, in preparation). In the immediate vicinity of a service vessel, noise could disturb marine mammals; however, this effect would be limited in area and duration.

4.1.1.8. Offshore Transport

4.1.1.8.1. Pipelines

Pipelines are the primary method used to transport a variety of liquid and gaseous products between OCS production sites and onshore facilities around the GOM. These products include unprocessed (bulk) oil and gas; mixtures of gas and condensate; mixtures of gas and oil; processed condensate, oil, or gas; produced water; methanol; and a variety of chemicals used by the OCS industry offshore. Product stream quality, available pipeline capacity, and existing infrastructure would be factors influencing the potential for new pipelines in the proposed lease sale area. **Figure 4-3** shows the existing and proposed pipelines in and near the proposed lease sale area.

Pipelines in the GOM are designated as either trunklines or gathering lines. Gathering lines are typically shorter segments of small-diameter pipelines that transport the well stream from one or more wells to a production facility or from a production facility to a central facility serving one or several leases, e.g., a trunkline, central storage, or processing terminal. Trunklines are typically large-diameter pipelines that receive and mix similar production products and transport them from the production fields to shore. A trunkline may contain production from many discovery wells drilled on several hydrocarbon fields. The OCS-related pipelines near shore and onshore may merge with pipelines carrying materials produced in State territories for transport to processing facilities or to connections with pipelines located further inland (**Chapter 4.1.2.1.7.**, Coastal Pipelines).

Regulatory processes and jurisdictional authority concerning pipelines on the OCS and in coastal areas are shared by several Federal agencies. The MMS is responsible for regulatory oversight of the design, installation, and maintenance of OCS producer-operated oil and gas pipelines. The DOT is responsible for establishing and enforcing design, construction, operation, and maintenance regulations, and for investigating accidents for all OCS transportation pipelines beginning downstream of the point at which operating responsibility transfers from a producing operator to a transporting operator. The MMS's responsibility extends upstream from the transfer point described above. **Chapter 1.5.**, Postlease Activities (Pipelines, and Pollution Prevention), discusses MMS's requirements in more detail.

Pipelines installed in water depths less than 200 ft (61 m) are required to be buried to a depth of at least 3 ft (30 CFR 250.1003). In addition, pipelines crossing fairways require a COE permit and must be buried to a depth of at least 10 ft and to 16 ft if crossing an anchorage area. Pipelines constructed as a result of a proposed action are not projected to be constructed in less than 200 ft or cross a fairway or anchorage area; therefore, no pipeline burials are projected as a result of a proposed action.

The bundling of pipelines is a cost-saving technique of laying more than one pipeline together. This procedure is less frequent in deep water due to safety, maintenance and repair, and security issues. Therefore, new pipelines constructed as a result of a proposed action are not projected to be bundled.

The merging of new pipelines with existing pipelines is based on two main issues: the capacity of the line and the compatibility of the products. The FERC can institute equal access by deciding if the merging line has enough capacity to handle the proposed inflow and if the new product would be compatible with the current product flowing through the line. It is expected that pipelines constructed as a result of a proposed action would connect to existing or proposed pipelines in and near the proposed lease sale area (**Figure 4-3**), resulting in no new pipeline landfalls.

The method for installing offshore pipelines in deeper water, like the proposed lease sale area, is the J-lay method. Lengths of pipe are joined to each other by welding or other means while supported in a vertical or near-vertical position by a tower. As more pipe lengths are added to the string, the string is lowered to the ocean floor. The configuration resembles a "J." Pipelines projected to be installed as a result of a proposed action would be in water depths greater than 500 m, where DP lay barges would be used. Therefore, pipelines constructed as a result of a proposed action would be installed using the J-lay method with a DP lay barge. Anchoring would not be required.

Pipelines located in deep water endure high hydrostatic pressure, cold temperatures, low visibility, varying subsurfaces, and strong bottom currents, which can all lead to great physical stress on the pipe and installation equipment. Depending on the location, pipeline installation activities in deepwater areas can be difficult both in terms of route selection and construction. The sea bottom surface can be extremely irregular and present engineering challenges (e.g., high hydrostatic pressure, cold temperatures, and darkness, as well as varying subsurface and bottom current velocities and directions). A rugged seafloor may cause terrain-induced pressures within the pipe that can be operationally problematic, as the oil must be pumped up and down steep slopes. An uneven seafloor could result in unacceptably long lengths of unsupported pipeline, referred to as "spanning," which in turn could lead to pipe failure from bending stress early in the life of the line. It is important to identify areas where significant lengths of pipeline may go unsupported. Accurate, high-resolution geophysical surveying becomes increasingly important in areas with irregular seafloor. Recent advances in surveying techniques have significantly improved the capabilities for accurately defining seafloor conditions, providing the resolution needed to determine areas where pipeline spans may occur. After analyzing survey data, the operator chooses a route (reviewed by MMS) that minimizes pipeline length and avoids areas of seafloor geologic structures and obstructions that might cause excessive pipe spanning, unstable seafloor, and potential benthic communities.

The greater pressures and colder temperatures in deep water present difficulties with respect to maintaining the flow of crude oil and gas through pipelines. Under these conditions, the physical and chemical characteristics of the produced hydrocarbons can lead to the accumulation of gas hydrate, paraffin, and other substances within the pipeline. These accumulations can restrict and eventually block flow if not successfully prevented and/or abated. There are physical and chemical techniques that can be applied to manage these potential accumulations. The leading strategy to mitigate these deleterious effects is to minimize heat loss from the system by using insulation. Other measures include forcing plunger-like "pigging" devices through the pipeline to scrape the pipe walls clean and the continuous injection of flow-assurance chemicals (e.g., methanol or ethylene glycol) into the pipeline system to minimize the formation of flow-inhibiting substances. However, the great water depths of the OCS and the extreme distance to shoreside facilities make these flow-assurance measures difficult to implement and can significantly increase the cost to produce and transport the product. Companies are continuously looking for and developing new technologies such as electrically and water-heated pipelines and burial of pipelines in deep water for insulation purposes.

Long-distance transport of multiphase well-stream fluids can be achieved with an effectively insulated pipeline. There are several methods to achieve pipeline insulation: pipe-in-pipe systems, which included electrically and water-heated pipelines; pipe with insulating wrap material; and as previously mentioned, buried pipelines where the soils act as an insulator. The design of all of these systems seeks a balance between the high cost of the insulation, the intended operability of the system, and the acceptable risk level. Such systems minimize the costs, revenue loss, and risks from the following:

- hydrate formation during steady state or transient flowing conditions;
- paraffin accumulation on the inner pipe wall that can result in pipeline plugging or flow rate reductions;
- adverse fluid viscosity effects at low temperatures that lead to reduced hydraulic performance or to difficulties restarting a cooled system after a short shut-in; and
- additional surface processing facilities required to heat produced fluids to aid in the separation processes.

Formation of gas hydrates in deepwater operations is a well-recognized and potentially hazardous operational problem in water depths greater than 1,000 ft (300 m). Seabed conditions of high pressure and low temperature become conducive to gas hydrate formation in deep water. Gas hydrates are ice-like crystalline solids formed by low-molecular-weight hydrocarbon gas molecules (mostly methane) combining with produced water. The formation of gas hydrates is potentially hazardous because hydrates can restrict or even completely block fluid flow in a pipeline, resulting in a possible overpressure condition. The interaction between the water and gas is physical in nature and is not a chemical bond. Gas hydrates are formed and remain stable over a limited range of temperatures and pressures.

Hydrate prevention is normally accomplished through the use of methanol, ethylene glycol, or tri-ethylene glycol as inhibitors, and the use of insulated pipelines and risers. Chemical injection is sometimes provided both at the wellhead and at a location within the well just above the subsurface safety valve. Wells that have the potential for hydrate formation can be treated with either continuous chemical injection or intermittent or "batch" injection. In many cases, batch treatment is sufficient to maintain well flow. In such cases, it is necessary only to inject the inhibitor at well start-up, and the well would continue flowing without the need for further treatment. In the event that a hydrate plug should form in a well that is not being injected with a chemical, the remediation process would be to depressurize the pipelines and inject the chemical. Hydrate formation within a gas line can be eliminated by dehydrating the gas with a glycol dehydrating system prior to input of gas into the line. In the future, molecular sieve and membrane processes may also be options for dehydrating gas. Monitoring of the dewpoint downstream of the dehydration tower should take place on a continuous basis. In the event that the dehydration equipment is bypassed because it may be temporarily out of service, a chemical could be injected to help prevent the formation of hydrates if the gas purchaser agrees to this arrangement beforehand.

Hydrocarbon flows that contain paraffin or asphaltenes may occlude pipelines as these substances, which have relatively low melting points, form deposits on the interior walls of the pipe. To help ensure product flow under these conditions, an analysis should be made to determine the cloud point and hydrate formation point during normal production temperatures and pressures. To minimize the formation of paraffin or hydrate depositions, wells can be equipped with a chemical injection system. If, despite treatment within the well, it still becomes necessary to inhibit the formation of paraffin in a pipeline, this can be accomplished through the injection of a solvent such as diesel fuel into the pipeline.

Pigging is a term used to describe a mechanical method of displacing a liquid in a pipeline or to clean accumulated paraffin from the interior of the pipeline by using a mechanized plunger or "pig." Paraffin is a waxy substance associated with some types of liquid hydrocarbon production. The physical properties of paraffin are dependent on the composition of the associated crude oil, and temperature and pressure. At atmospheric pressure, paraffin is typically a semisolid at temperatures above about 100 ^{o}F and would solidify at about 50 ^{o}F. Paraffin deposits would form inside pipelines that transport liquid hydrocarbons and, if some remedial action such as pigging were not taken, the deposited paraffin would eventually completely block all fluid flow through the line. The pigging method involves moving a pipeline pig through the pipeline to be cleaned. Pipeline pigs are available in various shapes and are made of various materials, depending on the pigging task to be accomplished. A pipeline pig can be a disc or a spherical or cylindrical device made of a pliable material such as neoprene rubber and having an outside diameter nearly equal to the inside diameter of the pipeline to be cleaned. The movement of the pig through the pipeline is accomplished by applying pressure from gas or a liquid such as oil or water to the back or upstream end of the pig. The pig fits inside the pipe closely enough to form a seal against the applied pressure. The applied pressure then causes the pig to move forward through the pipe. As the pig travels through the pipe, it scrapes the inside of the pipe and sweeps any accumulated contaminants or liquids ahead of it. In deepwater operations, pigging would be used to remove any paraffin deposition in the pipelines as a normal part of production operations. Routine pigging would be required of oil sale lines at frequencies determined by production rates and operating temperatures. The frequency of pigging could range from several times a week to monthly or longer, depending on the nature of the produced fluid. In cases where paraffin accumulation cannot be mitigated, extreme measures can be taken in some cases, such as coil tubing entry into a pipeline to allow washing (dissolving) of paraffin plugs. If that fails, then it could result in having to replace a pipeline.

Review of pipeline applications includes the evaluation of protective safety devices such as pressure sensors and automatic valves, and the physical arrangement of those devices proposed to be installed by the applicant for the purposes of protecting the pipeline from possible overpressure conditions and for detecting and initiating a response to abnormally low-pressure conditions. Once a pipeline is installed, operators conduct monthly overflights to inspect pipeline routes for leakage. **Chapter 1.5.**, Postlease Activities (Pollution Prevention), discusses this topic in depth.

Applications for pipeline decommissioning must also be submitted for MMS review and approval. Decommissioning applications are evaluated to ensure they will render the pipeline inert, to minimize the potential for the pipeline becoming a source of pollution by flushing and plugging the ends, and to minimize the likelihood that the decommissioned line will become an obstruction to other users of the OCS by filling it with water and burying the ends.

Proposed Action Scenario: Four pipelines (2 natural gas and 2 crude oil) with a total length of 50-800 km are projected as a result of a proposed action. **Figure 4-3** shows several existing and proposed pipelines that extend into deep water (>500 m) in and near the proposed lease sale area. It is expected that pipelines from proposed action facilities would connect to these existing or proposed pipelines, resulting in no new pipeline landfalls. Because of the projected water depth in which the proposed pipelines would be installed, the scenario assumes no anchoring due to DP lay barges, no bundling, and no burying.

The number and length of new pipelines were estimated using the amount of production, number of wells, and number of structures projected as a result of proposed action, rather than the number of leases resulting from a proposed lease sale. The range in length of pipelines projected is due to the uncertainty of the location of new wells or structures, and which existing or proposed pipelines would be utilized. Many factors would affect the actual transport system, including company affiliations, amount of production, product type, and system capacity.

Gulfwide OCS Program Scenario: From 2003 to 2042, 27,600-52,400 km of new pipeline are projected as a result of the Gulfwide OCS Program (**Table 4-3**).

4.1.1.8.2. Service Vessels

Service vessels are one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. In addition to offshore personnel, service vessels carry cargo (i.e., freshwater, fuel, cement, barite, liquid drilling fluids, tubulars, equipment, and food) offshore. A trip is considered the transportation from a service base to an offshore site and back; in other words, a round trip. Based on MMS calculations, an average of 6-9 vessel trips are required per week for 42 days in support of drilling an exploration well and for 33 days in support of drilling a development well. A platform is estimated to require two vessel trips per week over its 33-year production life. All trips are assumed to originate from the service base.

There are currently approximately 376 supply vessels operating in the GOM. Over the 40-year life of a proposed action, supply vessels would retire and replacement vessels would be built. In general, the new type of vessels built would continue to be larger, deeper drafted, and more technologically advanced for deepwater activities. In the short term, if any oversupply of deepwater vessels develops, some of the smaller deepwater vessels (200-220 ft) would be forced to work in shallow waters where they would compete with the older 180-ft vessels for jobs. Oversupply could result from lower OCS activity (decreased demand) or from construction of too many vessels (increased supply).

Support of deepwater operations (such as those expected in the proposed lease sale area) would continue to be the future of the service-vessel industry. Compared to shelf-bound service vessels, deepwater service vessels have improved hull designs (increased efficiency and speed), a passive computerized anti-roll system, drier and safer working decks, increased cargo capacity (water, cement, barite, drilling muds, etc.), increased deck cargo capability, increased cargo transfer rates to reduce the time and risk alongside structures (e.g., TLP), dual and independent propulsion systems, true dynamic positioning systems, fuel and NO_x efficient engines, and Safety of Life at Sea (SOLAS) capability (*WorkBoat*, 1998). Service vessels primarily used in deep water are OSV's, fast supply vessels, and AHTS's (*WorkBoat*, 2000). Other deepwater specialty service vessels include well stimulation vessels. The OSV's and AHTS's carry the same type of cargo (freshwater, fuel, cement, barite, liquid drilling fluids, tubulars, equipment, food, and miscellaneous supplies) but have different functions. The AHTS's also differ from the supply vessels by their deepwater mooring deployment and towing capabilities.

Consolidation may continue within the industry as smaller operations are unable to compete with the larger, more advanced companies. Also, issues such as logistics and boat pooling would continue to emerge as bottom line accounting persists to direct the offshore oil and gas industry.

Proposed Action Scenario: Service-vessel trips projected for a proposed action are 8,000-9,000 trips (**Table 4-2**). This equates to an average annual rate of 200-225 trips. Service-vessel trips during peak-year activity (year 11) are estimated as 300-500 trips.

Gulfwide OCS Program Scenario: The projected number of service-vessel trips estimated for the Gulfwide OCS Program is 11,889,000-12,479,000 over the 2003-2042 period (**Table 4-3**). This equates to an average rate of 297,225-311,975 trips annually.

4.1.1.8.3. Helicopters

Helicopters are one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. Helicopters are routinely used for normal crew changes and at other times to transport management and special service personnel to offshore exploration and production sites. In addition, equipment and supplies are sometimes transported. A trip is considered the transportation from a helicopter hub to an offshore site and back; in other words, a round trip. Based on MMS calculations, an average of 3-10 helicopter trips are required per week for 42 days in support of drilling an exploration well and for 33 days in support of drilling a development well. A platform is estimated to require two helicopter trips per week over its 33-year production life. All trips are assumed to originate from the service base.

Deepwater operations (such as those expected in the proposed lease sale area) require helicopters that travel farther and faster, carry more personnel, are all-weather capable, and have lower operating costs. There are several issues of concern for the helicopter industry's future. Because the tasks the offshore helicopter industry provides are the same tasks supply vessels provide, they are competition for one another. Fast boats are beginning to erode the helicopter industry's share of the offshore transportation business, particularly in shallow water. The exploration and production industry is outsourcing more and more operations to oil-field support companies who are much more cost conscious and skeptical about the high cost of helicopters. Another consideration for the helicopter industry is new technology such as subsea systems. These systems decrease the number of platforms and personnel needed offshore, therefore reducing the amount of transportation needed.

Proposed Action Scenario: Helicopter trips projected for a proposed action are 7,000-9,000 trips (**Table 4-2**). This equates to an average annual rate of 175-225 trips. The number of helicopter trips during peak year activity (year 11) is estimated as 300-400 trips.

Gulfwide OCS Program Scenario: The projected number of helicopter trips for the Gulfwide OCS Program is 27,997,000-50,692,000 trips over the 2003-2042 period (**Table 4-3**). This equates to an average rate of 699,925-1,267,300 trips annually.

4.1.1.8.4. Alternative Transportation Methods of Natural Gas

As the country's gas consumption is expected to increase by 65 percent over the next 20 years (USDOE, EIA, 2001b), industry is looking at alternative methods of transporting OCS gas in the GOM. These methods involve transporting natural gas as LNG or compressed natural gas (CNG) in specially designed vessels. The focus has been on deep water where it is costly and technically challenging to install pipelines to transport gas. The LNG and CNG options may make it economically viable to produce marginal gas fields. The CNG option may also be an economical way of transporting "stranded" associated gas instead of the gas being flared or reinjected. Although both technologies could bring gas to shore, most discussions suggest the use of offshore terminals and the existing nearshore pipeline infrastructure. The offloading platforms would require USCG-designated safety zones with "no surface occupancy" restrictions for oil and gas exploration, development, and production operations.

In the LNG process, gas is super-cooled, reducing its volume to a fraction of its gaseous state. Then, tankers with specially designed cargo holds transport the LNG to terminals for regasification. At present, LNG is being imported into four existing U.S. terminals, and more terminals are proposed. The LNG imports already travel through the GOM to one of the existing terminals at Lake Charles, Louisiana.

The CNG process uses less of the energy because liquefaction and regasification are not required as it is with LNG. The CNG technology is not currently being used to transport gas. The first application of CNG would be a pilot project shipping gas from Venezuela or Trinidad to Curacao (Cran and Stenning Technology Inc., 2001).

4.1.1.9. Hydrogen Sulfide and Sulfurous Petroleum

Sulfur may be present in oil as elemental sulfur, within H_2S gas, or within organic molecules, all three of which vary in concentration independently. Although sulfur-rich petroleum is often called "sour" regardless of the type of sulfur present, the term "sour" should properly be applied to petroleum containing appreciable amounts of H_2S, and "sulfurous" should be applied to other sulfur-rich petroleum types. Using this terminology, the following matrix of concerns is recognized:

Potentially Affected Endpoint	Sour Natural Gas	Sour Oil	Sulfurous Oil
Engineering components or facility equipment and pipeline	Corrosion	Corrosion	N/A
On-platform industrial hygiene	Irritation, injury, and lethality from leaks	Irritation, injury, and lethality from outgassing from spilled oil	Irritation, injury, and lethality from exposure to sulfur oxides produced by flaring
Off-platform general human health and safety	Irritation, injury, and lethality from leaks	Irritation, injury, and lethality from outgassing from spilled oil	Irritation, injury, and lethality from exposure to sulfur oxides produced by flaring
Marine and coastal species and habitats	Irritation, injury, and lethality from leaks	Synergistic amplification of oil-spill impacts from outgassing	No effects other than impacts hydrocarbon contact and acid rain

4.1.1.9.1. Sour Oil, Sour Gas, and Sulfurous Oil in the Gulf of Mexico

4.1.1.9.1.1. Occurrence

Sour oil and gas occur sparsely throughout the GOM OCS (e.g., about 65 operations had encountered H_2S-bearing zones in the GOM as of mid-1998), but principally offshore of the Mississippi Delta (Louisiana), Mississippi, and Alabama. Occurrences of H_2S offshore of Texas are in Miocene rocks and occur principally within a geographically narrow band. The occurrences of H_2S offshore Louisiana are mostly on or near piercement domes with caprock and are associated with salt and gypsum deposits. Examination of industry exploration and production data show that H_2S concentrations vary from as low as fractional parts per million in either oil or gas to 650,000 ppm in the gas phase of a single oil well near the Mississippi Delta. The next highest concentrations of H_2S encountered to date are in the range of 20,000-55,000 ppm in some natural gas wells offshore of Mississippi/Alabama. There is some evidence that petroleum from deepwater plays may be sulfurous, but there is no evidence that it is sour.

Only 5 percent of all wells drilled on the OCS to date have penetrated sediments below 15,000 ft subsea. The MMS estimates that there could be 5-20 Tcf of recoverable gas resources below 15,000 ft. Deep gas reservoirs on the GOM continental shelf are likely to have high corrosive content, including H_2S. To encourage exploration and development of deep gas prospects on the continental shelf, MMS offered incentives in the form of royalty relief on deep gas production from any new leases issued in Lease Sale 178 (March 2001). Such royalty relief may well be extended to deep gas production on other existing and future leases.

4.1.1.9.1.2. Treatment (Sweetening)

Removal of H_2S from sour petroleum may proceed in one of two ways. The product can either be “sweetened” (removal of H_2S from the hydrocarbons) offshore or it can be transported onshore to a processing facility equipped to handle H_2S hydrocarbons, where the product is sweetened. Several processes based on a variety of chemical and physical principles have been developed for gas sweetening. The processes include solid bed absorption, chemical solvents (e.g., amine units), physical solvents, direct conversion of H_2S to sulfur (e.g., Claus units), distillation, and gas permeation (Arnold and Stewart, 1988). Gas streams with H_2S or SO_2 are frequently treated offshore by amine units to reduce the corrosive properties of the product. A by-product of this process is a concentrated acid gas stream, which is frequently treated as a waste and flared if SO_2 emissions are not of concern. In cases where SO_2 emissions must be minimized, other options for handling acid gas must be sought. Sulfur recovery units to further process the H_2S to elemental sulfur or reduced sulfur compounds is a common method of treating acid gas streams. Reinjection of acid gas is an option that has also been considered. The feasibility of reinjecting acid gas in the offshore environment has not been demonstrated. In addition, MMS conservation requirements may not allow reinjection of this gas. Another option would be to send the untreated gas to shore for treatment; this requires the use of "sour gas" pipelines built to handle the highly corrosive materials.

4.1.1.9.1.3. Requirements for Safety Planning and Engineering Standards

The MMS reviews all proposed actions in the GOM OCS for the possible presence of H_2S. Activities found to be associated with a presence of H_2S are subjected to further review and requirements. Federal regulations at 30 CFR 250.417 require all lessees, prior to beginning exploration or development operations, to request a classification of the potential for encountering H_2S. The classification is based on previous drilling and production experience in the areas surrounding the proposed operations, as well as other factors. All operators on the OCS involved in production of sour gas or oil (i.e., greater than 20 ppm H_2S) are also required to file an H_2S contingency plan. This plan delimits procedures to ensure the safety of the workers on the production facility. In addition, all operators are required to adhere to NACE's Standard Material Requirement MR.01-75-96 for Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment (NACE, 1990). These engineering standards serve to enhance the integrity of the infrastructure used to produce the sour oil and gas, and further serve to ensure safe operations. The MMS has issued a final rule governing requirements for preventing hydrogen sulfide releases, detecting and monitoring hydrogen sulfide and sulfur dioxide, protecting personnel, providing warning systems, and establishing requirements for hydrogen sulfide flaring. The rule went into effect on March 28, 1997. An associated NTL (98-16) titled "Hydrogen Sulfide (H_2S) Requirements" was issued on August 10, 1998, to provide clarification, guidance, and information on the revised requirements. The NTL provides guidance on sensor location, sensor calibration, respirator breathing time, measures for protection against sulfur dioxide, requirements for classifying an area for the presence of H_2S, requirements for flaring and venting of gas containing H_2S, and other issues pertaining to H_2S-related operations.

4.1.1.9.2. Environmental Fate of H_2S

4.1.1.9.2.1. Atmospheric Release

Normal dispersion mechanisms in the surface mixed layer of the atmosphere (wind, etc.) cause natural gas leaks and associated H_2S to disperse away from release sites. The MMS reviews of proposed sour gas operations are based on the conservative assumptions of horizontal, noncombusted releases to achieve environmentally conservative results, although vertical release or combustion of the gas plume (greatly reducing potential exposure) would be possible. Both simple Gaussian estimation techniques (conforming to air quality rules) and more rigorous analytical modeling are used in MMS reviews of activities associated with a presence of H_2S. For a very large facility (throughput on the order of 100 MMcfd of produced natural gas) with high concentration levels (on the order of 20,000 ppm) and using very calm winds (speed of <1 m per second (sec)), H_2S levels reduce to 20 ppm at several kilometers from the source; H_2S levels are reduced to 500 ppm at 1 km. Six sites within the Eastern GOM meet this description. One site is off Alabama and the other sites are in the CPA to the west of the proposed lease sale area. Most "sour gas" facilities have H_2S concentrations below 500 ppm, which reduces to 20 ppm within the dimensions of a typical platform (or considerably less).

4.1.1.9.2.2. Aquatic Release

Hydrogen sulfide is soluble in water with 4,000 ppm dissolving in water at 20^{o}C and one atmosphere pressure. This implies that a small sour gas leak would result in almost complete dissolution of the contained H_2S into the water column. Larger leaks would result in proportionally less dissolution, depending on turbulence, depth of release, and temperature; and H_2S could be released into the atmosphere if the surrounding waters reach saturation or the gas plume reaches the surface before complete dissolution. Because the oxidation of H_2S in the water column takes place slowly (on the order of hours), the chemical oxygen demand of H_2S is spread out over a long time interval (related to the ambient current speed) and should not create appreciable zones of hypoxia, except in the case of a very large, long-lived submarine release.

4.1.1.9.3. H_2S Toxicology

4.1.1.9.3.1. Humans

The Occupational Safety and Health Administration's permissible exposure limit for H_2S is 20 ppm. A permissible exposure limit is an allowable exposure level in workplace air averaged over an 8-hour workshift. The American Conference of Governmental Hygienists recommends a time weighted average concentration of 10 ppm. The time-weighted average is a concentration for a normal 8-hour workday to which nearly all workers may be repeatedly exposed, day after day, without adverse affect. This is 10 times lower than the "immediately dangerous to life and health" level of 100 ppm set by the National Institute for Occupational Safety and Health. Despite a normal human ability to smell H_2S at levels below 1 ppm, H_2S is considered to be an insidious poison because the sense of smell rapidly fatigues, failing to detect H_2S after continued exposure. At 20 ppm MMS requires an operator to develop and file a H_2S Contingency Plan, and at 500 ppm an operator is required to model atmospheric dispersion of total, horizontal, noncombusted rupture.

4.1.1.9.3.2. Wildlife

While impacts on humans are well documented, the literature on the impact of H_2S on wildlife is sparse, with no information available for marine mammals and turtles.

In general, birds seem more tolerant of H_2S than mammals, indicating that birds may have a higher blood capacity to oxidize H_2S to nontoxic forms. In tests with white leghorn chickens, all birds died when inhaling H_2S at 4,000 ppm. At 500 ppm, no impact was observed on ventilation, while between 2,000 and 3,000 ppm respiratory frequency and tidal volume become irregular and variable in these birds (Klentz and Fedde, 1978). In the western United States, oil production and geothermal operations often flare or vent pipes to release the natural gases accumulated during drilling, storage, and pipeline operations, with significant impacts on wildlife (Maniero, 1996). Numerous instances of dead birds at the release site have been reported in the literature; extremely high concentrations of H_2S would occur at these sites.

4.1.1.9.3.3. Fish

Most adult marine fish will avoid any water column that is contaminated with H_2S, provided an escape route is available. In terms of acute toxicity testing, fish can survive at levels reaching 0.4 ppm (Van Horn, 1958; Theede et al., 1969). Walleye eggs (*Stizostedion vitreum*) did not hatch at levels from 0.02 to 0.1 ppm (USEPA, 1986). The hatchability of northern pike (*Esox lucius*) was substantially reduced at 25 ppb with complete mortality at 45 ppb. Northern pike fry had 96-hour lethal concentration where 50 percent of organisms die (LC_{50}) values that varied from 17 to 32 ppb at O_2 levels of 6 ppm. Sensitive eggs and fry of northern pike exhibited no observable effects at 14 and 4 ppb, respectively (Adelman and Smith, 1970; USEPA, 1986). In a series of tests on the eggs, fry, and juveniles of walleyes, white suckers (*Catostomus commersoni*), and fathead minnows (*Pimephales promelas*), with various levels of H_2S from 2.9 to 12 ppb, eggs were the least sensitive while juveniles were the most sensitive. In 96-hour bioassays, fathead minnows and goldfish (*Carassius auratus*) varied greatly in tolerance to H_2S with changes in temperature (Smith et al., 1976; USEPA, 1986). Pacific salmon (*Oncorhynchus* sp.) experienced 100 percent mortality within 72 hours at 1 ppm.

On the basis of chronic toxicity testing, juveniles and adults of bluegill *(Lepomis macrochirus*) exposed to 2 ppb survived and grew normally. Egg deposition in bluegills was reduced after 46 days of exposure to 1.4 ppb (Smith et al., 1976; USEPA, 1986). White sucker eggs were hatched at 15 ppb, but juveniles showed growth reductions at 1 ppb. Safe levels for fathead minnows were between 2 and 3 ppb. For *Gammarus pseudolimnaeus* and *Hexagenia limbata*, 2 and 15 ppb, respectively, were considered safe levels (USEPA, 1986).

4.1.1.10. New or Unusual Technologies

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

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

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

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

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

4.1.1.11. Decommissioning and Removal Operations

During exploration, development, and production operations, the seafloor around activity sites within the proposed lease sale area becomes the repository of temporary and permanent equipment and structures. In compliance with Section 22 of MMS's Oil and Gas Lease Form (MMS-2005) and OCS regulations (30 CFR §250.1710 – wellheads/casings and 30 CFR §250.1725 – platforms and other facilities), lessees are required to remove all seafloor obstructions from their leases within one year of lease termination or relinquishment. These regulations require lessees to sever bottom-founded structures and their related components at least 5 m below the mudline to ensure that nothing would be exposed that could interfere with future lessees and other activities in the area. The structures are generally grouped into two main categories depending upon their relationship to the platform/facilities (piles, jackets, caissons, templates, mooring devises, etc.) or the well (i.e., wellheads, casings, casing stubs, etc.).

Since the water depths in the proposed lease sale area range from 1,600 to 3,000 m, the types and numbers of platforms or facilities would be greatly limited. Drilling operations would be conducted from floating drilling rigs (FDR), primarily semisubmersibles and drillships. Most of the FDR's that would be used in the proposed lease sale area are DP vessels (DPV); vessels that employ onboard thrusters, computer-linked to global positioning systems to maintain stationkeeping above the drillsite. Some semisubmersibles possess anchoring capabilities that could be used in the shallowest depths of the proposed lease sale area; however, most drilling is projected to be conducted using DPV's due to the temporary nature of exploratory drilling coupled with the complexities and economics of ultra-deep mooring operations.

Production facilities in the proposed lease sale area would be semisubmersibles, SPAR's, and subsea systems. The TLP's, while suitable to the proposed lease sale's shallower water depth, is generally not economically feasible and FPSO's have not been authorized for use in the EPA. Despite the extreme water depths, the semisubmersibles and SPAR's would be held to the seafloor using standard catenary and taut mooring systems using an array of anchor devises (i.e., fluted, suction pile, suction embedded, plate, etc.). The mooring equipment is designed for disengagement and retrieval from the seafloor using handling tugs or heavy lift vessels (HLV) during facility decommissioning. Subsea systems consist of temporary and semipermanent seafloor equipment (i.e., manifolds, umbilicals, jumpers, flowlines, etc.) that eventually ties back to a supporting surface facility. Much like moorings, most subsea equipment is deployed in a manor to allow for retrieval once production has ceased. Any bottom-founded, subsea equipment or mooring devices that are not fully recoverable would be required to be removed to at least 5 m below the mudline (30 CFR §250.1728(a)).

Due to the amount of drilling activities that would occur throughout the life of a proposed action, the most prolific number of seafloor structures are projected to be well related (i.e., wellhead, casing, casing stub, etc.). An operator may choose to temporarily or permanently abandon a well depending upon a its usefulness and the status of the lease. A temporary well abandonment allows the operator to save the wellbore for future uses, to determine economic viability, and/or to await the construction/arrival of special equipment or facilities. Temporary well abandonment operations follow a set of guidelines (30 CFR §250.1721 & §250.1722) that ensures wellbores are adequately plugged, tested, and monitored; however, water depths in the proposed lease sale area eliminate additional regulations concerning navigation aids and fisheries protection devices. Permanent well abandonments also follow plugging guidelines (30 CFR §250.1715) to prevent any hydrocarbon seepage from reaching the seafloor or marine environment, but the wellhead or casing must be removed to at least 5 m below the mudline (30 CFR §250.1716(a)).

To comply with the aforementioned requirements for below mudline severing of wellheads, casings, and "unrecoverable" equipment and moorings, the lessees would be limited to methods that take into account the economic, regulatory, and operational restrictions of removals in ultra-deep water. Severing techniques available for use in the GOM can be grouped into explosive or nonexplosive methodologies. Gulfwide, the majority of permanent well abandonments and structure removals are performed using explosive charges since they offer the lessee a lower expense, quicker setup and severing time, and assuredness of cut. Conditions of the Structure Removal NTL (2001-G08), however, require a Section 7 ESA Consultation for any removal proposing explosives in water depths greater than 200 m because of possible affects on sperm whales. After discussing the time requirements of ESA Consultations (4-8 months) and related regulatory stipulations from MMPA with industry representatives, MMS projects no explosives would be used for decommissioning and removal operations in the proposed lease sale area. Despite the higher costs and longer on-site times, nonexplosive removal techniques offer the lessees fewer regulatory restrictions and mitigative conditions.

Depending on accessibility and the shape/configuration of the object to be cut, nonexplosive techniques are available that would allow for either internal or external severing. Internal-severing equipment is generally emplaced using the downhole capabilities of a FDR. For operations involving concentrically symmetrical objects, internal mechanical cutters are placed into the wellbore or accessible, bottom-founded equipment to sever the structure using hydraulically controlled blades. Abrasive slurry and abrasive jet cutters are also limited to concentrical objects, but in place of mechanical blades, a nozzle propels a mixture of pressurized water and abrasive particles (i.e., sand, slag, garnet, etc.) against the walls of the target to perform the severing. Due to the extreme water depths in the proposed lease sale area, most external-severing devices would need to be deployed or emplaced using ROV's. Some abrasive jet cutters have been modified into ROV-deployable, external-severing systems, but like their internal counterparts, they are limited to cylindrical objects. When an operation involves irregular, nonsymmetrical objects, mechanical cutting tools such as blades, hydraulic shears, and diamond wire saws/cutters can be mounted on ROV's. Operators also intend to rely on the versatility and availability of cutter-equipped ROV's for both normal and emergency severing of mooring lines and chains, pipelines, and other open-water components. However, bottom-founded structures present the main limitation to all external severing methods because it is necessary to jet or remove enough of the seafloor around the object to allow an external cut to be made at least 5 m below the mudline.

Since all water depths in the proposed lease sale area are greater than 800 m, OCS regulations would offer the lessees the option to avoid the jetting by requesting alternate removal depths for well abandonments (30 CFR §250.1716(b)(3)) and facilities (30 CFR §250.1728(b)(3)). Above mudline cuts would be allowed with reporting requirements on the remnant's description and height off of the seafloor to MMS – data necessary for subsequent reporting to the U.S. Navy. Additionally, industry has indicated that it plans to use the alternate removal depth options, coupled with quick-disconnect equipment (i.e., detachable risers, mooring disconnect systems, etc.) to fully abandon-in-place wellheads, casings, and other minor, subsea equipment without the need for any severing devices.

Site clearance guidelines for operations in the proposed lease sale area would be limited to exploratory or delineation well sites. Requirements outlined in MMS's Site Clearance NTL (98-26) limits the lessees to conducting stationary or towed, high-frequency (500 kHz) sonar verifications over 600-ft (183-m) diameter search areas, centered over the well sites. Since the previously-mentioned removal regulations allow for the objects or portions of objects to be left on the seafloor, MMS is currently discussing alternatives to the deepwater site clearance requirements, with pending modifications to the NTL.

Proposed Action Scenario: **Table 4-2** shows the number of production structures and wells projected to be installed/drilled by water-depth subarea. Two production structures are projected to be removed as a result of a proposed action; no explosives would be used. The MMS anticipates that all facility related equipment and moorings would be left on the seafloor following approved, alternate removal depth requests under 30 CFR §250.1728(b)(3). Of the 30-40 wells projected to be drilled as a result of a proposed action, none are projected to be removed using explosives. Agency forecasts indicate that the majority of wellhead structures would be abandoned-in-place as per removal regulations under 30 CFR §250.1716(b)(3), with the remainder being severed using nonexplosive methods.

Gulfwide OCS Program Scenario: **Tables 4-3 through 4-6** show the number of structures removed by water-depth subarea for the total Gulfwide OCS Program and by planning area. The number of structures to be removed in the next several decades is projected to exceed the number of production structures installed. It is estimated that a total of 10-12 production structures would be removed from the EPA during 2003-2042; however, it is anticipated that none of the existing or proposed structures in the EPA would require the use of explosives for their removal. It is estimated that a total of 5,350-6,110 production structures would be removed from the CPA during 2003-2042. The number of production structures installed landward of the 800-m isobath in the CPA to be removed using explosives during the interval of 2003-2042 is estimated at 3,676-4,183. It is estimated that a total of 943-1,174 production structures would be removed from the WPA during 2003-2042. It is estimated that 629-783 production structures installed landward of the 800-m isobath in the WPA would be removed using explosives during 2003-2042.

It is estimated that 8,996-11,333 exploration and delineation wells would be drilled Gulfwide as a result of the OCS Program. **Table 4-3** shows the estimated range of exploration and delineation wells by water depth subarea. Of these wells, approximately 0.5-0.7 percent would be in the EPA, 76-79 percent in the CPA, and 20-24 percent in the WPA. An estimate of 1-10 percent of permanently abandoned well casing stubs or wellhead structures would be removed by explosives Gulfwide (89-1,133 stubs) over years 2003-2042 of the OCS Program. Activity is projected to be relatively stable for the first 10 years of the analysis period, followed by a steady reduction in the annual rate of exploration and delineation wells to 50 percent.

4.1.2. Coastal Impact-Producing Factors and Scenario

This section describes the coastal infrastructure and activities (IPF's) associated with a proposed action that could potentially affect the biological, physical, and socioeconomic resources of the GOM. When appropriate, coastal IPF's associated with the Gulfwide OCS Program are discussed because some proposed action, IPF's (i.e., infrastructure) affect resources that are geographically Gulfwide and, therefore, are necessary for the cumulative analysis.

4.1.2.1. Coastal Infrastructure

4.1.2.1.1. Service Bases

A service base is a community of businesses that load, store and supply equipment, supplies and personnel that are needed at offshore work sites. Although a service base may primarily serve the OCS planning area and coastal subarea in which it is located, it may also provide significant services for the other OCS planning areas and coastal subareas. Expected proposed action service bases were ascertained based on well and platform plans in the proposed lease sale area and within 50 mi of the proposed lease sale area. In addition, information received from EPA Lease Sale 181 lessees with respect to potential service bases for the proposed lease sale area was used as a proxy for activity associated with a proposed action. Therefore, the ports in the Fourchon and Venice, Louisiana, and Mobile, Alabama, areas are expected to be used as primary service bases for a proposed action. Furthermore, five other ports are expected to be used as secondary service bases: Cameron, Houma, Intracoastal City, and Morgan City, Louisiana; and Pascagoula, Mississippi.

Fourchon is expected to receive 60 percent of the total number of projected vessel trips (both crew and supply) associated with a proposed action during the exploration phase. Venice is expected to service 30 percent, while Mobile is expected to receive only 10 percent of projected vessel trips. These percentages are expected to change during the development and production phase. If exploration in the EPA is successful, ECO plans to construct a C-Port in the Mobile area. This would shift vessels from Fourchon and Venice to Mobile during the development and production phase. Fourchon and Mobile are each expected to receive 45 percent of the total number of projected vessel trips associated with a proposed action, while Venice is expected to receive 10 percent.

As the industry continues to evolve so do the requirements of the onshore support network. With advancements in technology, the shore-side supply network would continue to be challenged to meet the needs and requirements of the industry. All supplies must be transported from land-based facilities to marine vessels or helicopters to reach offshore destinations. This uses both water and air transportation modes. The intermodal nature of the entire operation gives ports (which traditionally have water, rail, and highway access) a natural advantage as an ideal location for onshore activities and intermodal transfer points. Therefore, ports would continue to be a vital factor in the total process and must incorporate the needs of the offshore oil and gas industry into their planning and development efforts, particularly with regard to determining their future investment needs. In this manner both technical and economic determinants must influence the dynamics of port development.

Issues and concerns that must be addressed at the local level have resulted from the significant prosperity that has followed the industry. These extend beyond specific port needs into the community itself. Most of these problems can be nullified with additional infrastructure. However, additional infrastructure is difficult to develop. It is expensive to construct and requires substantial planning and construction time prior to completion. Rapidly developing technology has resulted in changing needs for the offshore oil and gas industry. This has placed a burden on the ports to provide the necessary infrastructure and support facilities required to meet the needs of the industry in a timely manner.

To continue to offer a viable service and to stay current with technological trends and industry standards, ports must be able to incorporate offshore oil and gas industry information into their planning for future infrastructure development, staffing needs, and other impacts associated with rapid industrial growth. Expansion of some existing service bases is expected to occur to capture and accommodate the current and future oil and gas business that is generated by development on the OCS and State waters. Some channels in and around the service bases would be deepened and expanded in support of deeper draft vessels and other port activities, some of which would be OCS related.

As OCS operations have progressively moved into deeper waters, larger vessels with deeper drafts have been phased into service, mainly for their greater range, faster speed, and larger carrying capacity. Services bases with the greatest appeal for deepwater activity have several common characteristics: strong and reliable transportation systems; adequate depth and width of navigation channels; adequate port facilities; existing petroleum industry support infrastructure; location central to OCS deepwater activities; adequate worker population within commuting distance; and insightful strong leadership. Typically, deeper draft service vessels require channels with depths of 6-8 m.

Proposed Action Scenario: A proposed action would not require any additional service bases. The ports in the Fourchon and Venice, Louisiana, and Mobile, Alabama, areas are expected to be used as primary service bases for a proposed action. The ports of Cameron, Houma, Intracoastal City, and Morgan City, Louisiana; and Pascagoula, Mississippi, are expected to be used as secondary service bases.

Gulfwide OCS Program Scenario: The Gulfwide OCS Program activities would continue to lead to a consolidation of port activities at specific ports especially with respect to deepwater activities (i.e., Fourchon, Galveston, and Mobile if Chouest builds a C-Port there). The Gulfwide OCS Program would require no additional service bases.

4.1.2.1.2. Helicopter Hubs

Helicopter hubs or "heliports" are facilities where helicopters can land, load, and offload passengers and supplies, refuel, and be serviced. These hubs are used primarily as flight support bases to service the offshore oil and gas industry. There are 128 heliports in the analysis area that support OCS activities. Three helicopter companies dominate the GOM offshore helicopter industry: Air Logistics, Era Aviation, and Petroleum Helicopters, Inc. A few major oil companies operate and maintain their own fleets, although this is a decreasing trend. Instead of running their own fleets, oil and gas companies are increasingly sub-contracting the whole operation on a turnkey basis to independent contractors. More and more operations are outsourcing to oil-field support companies, such as Baker Hughes, who are much more cost conscious and skeptical about the high cost of helicopters. Another consideration for the helicopter industry is new technology such as subsea systems. These systems decrease the number of platforms and personnel needed offshore, therefore reducing the amount of transportation needed.

To meet the demands of deep water (travel farther and faster, carry more personnel, be all-weather capable, and have lower operating cost), the offshore helicopter industry is purchasing new helicopters. While some heliports located farther inland have closed or consolidated, some heliports are expanding or opening due to more of the industry's work being farther offshore.

Expected proposed action helicopter hubs were ascertained based on well and platform plans in the proposed lease sale area and within 50 mi of the proposed lease sale area. In addition, information received from EPA Lease Sale 181 lessees with respect to potential helicopter hubs for the proposed lease sale area was used as a proxy for activity associated with a proposed action. Therefore, the ports in the Fourchon and Venice, Louisiana, and Mobile, Alabama, areas are expected to be used as primary helicopter hubs for a proposed action. Furthermore, five other ports are expected to be used as secondary helicopter hubs: Cameron, Houma, Intracoastal City, and Morgan City, Louisiana; and Pascagoula, Mississippi. Venice is expected to receive 50 percent of the total number of projected helicopter trips associated with a proposed action. Fourchon and Mobile are each expected to service 25 percent of projected helicopter trips. These percentages are not expected to change during the phases of development.

Proposed Action Scenario: A proposed action would not require additional helicopter hubs. The ports in the Fourchon and Venice, Louisiana, and Mobile, Alabama, areas are expected to be used as primary helicopter hubs for a proposed action. The ports of Cameron, Houma, Intracoastal City, and Morgan City, Louisiana; and Pascagoula, Mississippi, are expected to be used as secondary helicopter hubs.

OCS Progam Scenario: Minimal helicopter hub construction or closures are anticipated. While some heliports located farther inland have closed or consolidated, some heliports are expanding or opening because of more of the industry's work being farther offshore. No new heliports are projected as a result of the Gulfwide OCS Program; however, they may expand at current locations.

4.1.2.1.3. Construction Facilities

4.1.2.1.3.1. Platform Fabrication Yards

Given the platform fabrication industry's characteristics and trends therein, it is not likely that new yards would emerge. The existing fabrication yards do not operate as "stand alone" businesses; rather, they rely heavily on a dense network of suppliers of products and services. Also, since such a network has been historically evolving in Louisiana and Texas for over 50 years, the existing fabrication yards possess a compelling force of economic concentration to prevent the emergence of new fabrication yards. There are 43 platform fabrication yards in the analysis area.

With respect to the deepwater development (such as those expected in the proposed lease sale area), the challenges for the fabrication industry stem from the greater technical sophistication and the increased project complexity of the deepwater structures, such as compliant towers and floating structures. The needs of the deepwater projects are likely to result in two important trends for the fabrication industry. The first is the increasing concentration in the industry, at least with respect to the deepwater projects. As technical and organizational challenges continue to mount up, it is expected that not every fabrication yard would find adequate resources to keep pace with the demands of the oil and gas industry. The second trend is the closer integration—through alliances, amalgamations, or mergers—among the fabrication yards and engineering firms.

Proposed Action Scenario: No new facilities are expected to be constructed as a result of a proposed action.

Gulfwide OCS Program Scenario: No new facilities are expected to be constructed in support of Gulfwide OCS Program activities. Some current yards may close, be bought out, or merge over the 2003-2042 period resulting in fewer active yards in the analysis area.

4.1.2.1.3.2. Shipyards

The 1980's were dismal for the shipbuilding industry. Several mergers, acquisitions, and closings occurred during the downturn. Of those that have remained, 94 are located within the analysis area (**Table 4-7**). Several large companies dominate the oil and gas shipbuilding industry. Most yards in the analysis area are small. To a great extent, growth would be based on a successful resolution of several pertinent issues that have affected and would continue to affect shipbuilding in the U.S. and particularly in the analysis area: maritime policy, declining military budget, foreign subsidies, USCG regulations, OPA 90, financing, and an aging fleet.

Proposed Action Scenario: No new facilities are expected to be constructed as a result of a proposed action.

Gulfwide OCS Program Scenario: No new facilities are expected to be constructed in support of Gulfwide OCS Program activities. Some current yards may close, be bought out, or merge over the 2003-2042 period, which would result in fewer active yards in the analysis area.

4.1.2.1.3.3. Pipecoating Facilities and Yards

There are currently 19 pipecoating plants in the analysis area (**Table 4-7**). Pipecoating facilities receive manufactured pipe, which they then coat the surfaces of with metallic, inorganic, and organic materials to protect from corrosion and abrasion and to add weight to counteract the water's buoyancy. Two to four sections of pipe are then welded at the plant into 40-ft segments. The coated pipe is stored (stacked) at the pipeyard until it is needed offshore.

To meet deepwater demand, pipecoating companies have been expanding capacity or building new plants. A new trend in the industry is single-source contracts where the pipe manufacturing, coating, welding, and laying are all under one contract. This results in a more efficient, less costly operation. At present, though, only foreign companies have this capability.

Proposed Action Scenario: No new facilities are expected to be constructed as a result of a proposed action.

Gulfwide OCS Program Scenario: Current capacity, supplemented by recently built plants and expansions, are anticipated to meet Gulfwide OCS Program demand. No new facilities are expected to be constructed in support of Gulfwide OCS Program activities.

4.1.2.1.4. Processing Facilities

4.1.2.1.4.1. Refineries

A refinery is an organized arrangement of manufacturing units designed to produce physical and chemical changes to turn crude oil into petroleum products. In the refinery, most of the nonhydrocarbon substances are removed from crude oil and it is broken down into its various components and blended into useful products.

In the early 1980's, the Crude Oil Entitlements Program ended and crude oil prices were no longer controlled. This caused the number of petroleum refineries to drop sharply, leading to 13 years of decline in U.S. refining capacity. The decade of the 1990's was characterized by low product margins and low profitability. Refining operations consolidated, the capacity of existing facilities expanded, and several refineries closed. Most refineries are part of major, vertically integrated oil companies that are engaged in both upstream and downstream aspects of the petroleum industry. These companies dominate the refining industry, although most majors are spinning off their refinery facilities to independents or entering joint ventures to decrease the risk associated with low refining returns. The analysis area hosts over one-third of the petroleum refineries in the U.S. Most of the region's refineries are located in Texas and Louisiana (**Table 4-7**), representing 55.04 and 38.49 percent, respectively, of total U.S. refining capacity.

Two significant environmental considerations facing U.S. refiners are Phase 2 CAAA of 1990 reformulated motor gasoline (RFG) requirements and the growing public opposition to the use of methyl tertiary butyl ether (MTBE). In order to meet Phase 2 RFG requirements, U.S. refiners would incur numerous expenses and make substantial investments. The MTBE is an additive that increases the oxygen content of motor gasoline, causing more complete combustion of the fuel and less pollution. It was a relative inexpensive way for refiners to meet Phase 1 CAAA RFG requirements. Since March 1999, eight states have adopted bans on the use of MTBE because of concerns about groundwater contamination. This would cause additional outlays of money and some restructuring of current facilities in order to move to ethanol.

Distillation capacity is projected to grow from the 1998 year-end level of 16.3 million barrels per day to between 17.6 million and 18.3 million barrels per day in 2020. Almost all of the capacity additions are projected to occur on the Gulf Coast. Financial, environmental, and legal considerations make it unlikely that new refineries would be built in the United States; therefore, expansion at existing refineries likely would increase total U.S. refining capacity in the long-run. Refineries would continue to be used intensively, in a range from 93 to 96 percent of design capacity.

Proposed Action Scenario: No new facilities are expected to be constructed as a result of a proposed action.

Gulfwide OCS Program Scenario: No new facilities are expected to be constructed in support of Gulfwide OCS Program activities. While financial, environmental, and legal considerations make it unlikely that new refineries would be built in the U.S., expansion at existing refineries likely would increase total U.S. refining capacity over the 2003-2042 period.

4.1.2.1.4.2. Gas Processing Plants

After raw gas is brought to the earth's surface, it is processed at a gas processing plant to remove impurities such as water, carbon dioxide, sulfur, and inert gases and transformed into a saleable, useable energy source. The total number of natural gas processing plants operating throughout the U.S. has been declining over the past several years as companies have merged, exchanged assets, and closed older, less efficient plants. However, this trend was reversed in 1999. Louisiana, Mississippi, and Alabama's capacity is undergoing significant increases as a wave of new plants and expansions try to anticipate the increased gas coming ashore from new gas developments in the GOM. At present, there are 35 gas processing plants in the analysis area that process OCS gas (**Table 4-7**).

According to a study published by the Gas Research Institute, offshore GOM is the only area of the U.S. that offers potential new gas supplies for gatherers/processors. This is also the only region where any significant exploration is occurring. The MMS anticipates the construction of as many 4-16 new gas-processing plants along the Gulf Coast to process gas associated with the Gulfwide OCS Program (**Table 4-7**).

Proposed Action Scenario: No new facilities are expected to be constructed as a result of a proposed action.

Gulfwide OCS Program Scenario: Due to the potential for gas in the GOM OCS, MMS anticipates 4-16 new gas processing plants would be constructed along the Gulf Coast in support of Gulfwide OCS Program activities. Of these new plants, 1-5 are expected to be located in Texas, 3-9 in Louisiana, and 0-2 in the Mississippi-Alabama area.

4.1.2.1.5. Terminals

Terminals are onshore receiving facilities for OCS oil and gas, which includes pipeline shore facilities, barge terminals, and tanker port areas. All proposed action production associated with a proposed action is projected to be transported by pipeline. Barge terminals would only be used for production from shallower water, and tanker port areas would receive production shuttled from FPSO's in the CPA and WPA only.

4.1.2.1.5.1. Pipeline Shore Facilities

The term "pipeline shore facility" is a broad term describing the onshore location where the first stage of processing occurs for OCS pipelines carrying different combinations of oil, condensate, gas, and produced water. Pipelines carrying only dry gas do not require pipeline shore facilities; the dry gas is piped directly to the gas processing plant (**Chapter 4.1.2.1.4.2.**). Some processing may occur offshore at the platform; only onshore facilities are addressed in this section.

Pipeline shore facilities may separate, process, pump, meter, and store oil, water, and gas depending on the quality of the resource carried by the pipeline. After processing and metering, the liquids are either piped or barged to refineries or storage facilities. The gas is piped to a gas processing plant for further refinement, if necessary; otherwise, it is transported via transmission lines for distribution to commercial consumers. Water that has been separated out is usually disposed into on-site injection wells.

A pipeline shore facility may support one or several pipelines. Typical facilities occupy 2-25 ha. Although older facilities may be located in wetlands, current permitting programs prohibit or discourage companies from constructing any new facilities in wetlands.

Proposed Action Scenario: No new pipeline shore facilities are projected as a result of a proposed action. It is projected that a proposed action would represent a small percent of the resources handled by shore facilities in coastal Subarea LA-3.

Gulfwide OCS Program Scenario: A total of 12-20 new pipeline shore facilities are projected as a result of the Gulfwide OCS Program. Three to four new facilities are projected to be constructed in coastal Subarea LA-3.

4.1.2.1.6. Disposal and Storage Facilities for Offshore Operational Wastes

Both the GOM offshore oil and gas industry and the oil and gas waste management industry are undergoing significant changes. New drilling technologies and policy decisions as well as higher energy prices should increase the level of OCS activity and, with it, the volumes of waste generated. The oil-field waste industry, having been mired in somewhat stagnant conditions for almost two decades, has developed new increments of capacity, and some new entrants into the market have added to industry capacity and the diversity of technologies available for the industry to use.

Facilities that accept OCS-generated waste that is not unique to oil and gas operations, such as municipal waste landfills and hazardous waste treatment, storage and disposal facilities, are diverse and specialized and manage waste for the broad base of U.S. industry. The OCS activity does not generate a large part of the waste stream into these facilities and is not expected to be material to the overall capacity of the industry. Capacity of industrial waste management facilities is for the most part abundant, as U.S. industries have learned to minimize wastes they ship to offsite facilities for management.

Proposed Action Scenario: No new disposal and storage facilities would be built as a result of a proposed action.

Gulfwide OCS Program Scenario: No new disposal and storage facilities are expected to be constructed in support of Gulfwide OCS Program activities.

4.1.2.1.6.1. Nonhazardous Oil-field Waste Sites

Long-term capacity to install subsurface injection facilities onshore is itself not scarce, and oil-field waste injection well permits do not generally attract much public opposition. With the volume of produced water frequently exceeding the volume of oil a well produces by tenfold or more, the main limitation to widespread use of land-based subsurface injection facilities is the space at docks and the traffic in and out of ports.

With the addition of Trinity Field Services to the market, the OCS market has its first salt dome disposal operation in a competitive location, with 6.2 million barrels of space available initially. This is enough capacity to take 8-10 years' worth of OCS liquids and sludges at current generation rates and a potential of several times that amount with additional solution mining. Salt domes are well-known and well-documented geological structures, and others could be placed into service as demand dictates. Salt caverns are a finite resource, but nevertheless have the potential to take decades' worth of OCS offsite NOW generation.

Proposed Action Scenario: No new NOW waste sites would be built as a result of a proposed action. Capacity to manage waste generated by a proposed action's drilling and production activities is adequate for the present.

Gulfwide OCS Program Scenario: No new NOW waste sites would be built as a result of the Gulfwide OCS Program. Oil and gas waste management facilities along the Gulf Coast have adequate capacity now and for a hypothetical future that includes a doubling of current waste volumes.

4.1.2.1.6.2. Landfills

The use of landfarming of OCS waste is likely to decline further, particularly with greater availability of injection methods for wastes containing solids. Future regulatory efforts are likely to discourage the practice by adding requirements that damage the economics if not by an outright ban on future permits.

Even though growth in OCS waste volumes can be expected to follow a linear relationship with increased OCS drilling and production activity, landfills would continue to be a small factor in the reduction of trash generated by OCS activity. Assuming a landfill (1) presently had OCS waste constituting 5 percent of its waste stream, (2) the remaining life of a landfill was 20 years at current fill rates, and (3) OCS waste doubled but the rest of the incoming waste stream remained flat, then the OCS activities would cause the landfill to be close at the end of 19 years as a result of the OCS contribution increase. With no waste received from OCS activities at all, the landfill would close in 21 years.

Proposed Action Scenario: No new landfills would be built as a result of a proposed action.

Gulfwide OCS Program Scenario: No new landfill waste sites would be built as a result of the Gulfwide OCS Program. Landfills are a small factor in the reduction of trash generated by OCS activity.

4.1.2.1.7. Coastal Pipelines

This section discusses OCS pipelines in coastal waters (State offshore and inland waters) and coastal onshore areas. See **Chapter 4.1.1.8.1.** for a discussion of pipelines in Federal offshore waters. The OCS pipelines near shore and onshore may join pipelines carrying production from State waters or territories for transport to processing facilities or to distribution pipelines located farther inland. See **Chapter 4.1.3.1.2.** for a discussion of pipelines supporting State oil and gas production.

Pipelines in coastal waters may present a hazard to commercial fishing where bottom-trawling nets are used; this is one reason that pipelines must be buried in waters less than 200 ft. Pipeline burial is also intended to reduce the movement of pipelines by high currents and storms, to protect the pipeline from the external damage that could result from anchors and fishing gear, and to minimize interference with the operations of other users of the OCS. For the nearshore sections of OCS pipelines, COE and State permits for constructing pipelines require that turbidity impacts to submerged vegetation be mitigated through the use of turbidity screens and other turbidity reduction or confinement equipment.

As a mitigation measure to avoid adverse effects of barrier beaches and wetlands, most pipeline landfalls crossing barrier beaches and wetlands would be directionally bored under them.

The cumulative analysis discusses the MMS/USGS National Wetland Research Center's (NWRC) current study of coastal wetland impacts from pipeline construction and associated widening of canals utilizing USGS habitat data. Preliminary results from this study are summarized below (Johnston and Barras, personal communication, 2002):

> Approximately 15,400 km (9,570 mi) of OCS pipelines have been constructed in Louisiana from the 3-mi State/Federal boundary to the CZM boundary. Of those pipelines, approximately 8,000 km (4,971 mi) crossed wetland (marsh) or upland habitat. The remaining 7,400 km (4,598 mi) crossed waterbodies. Sources of OCS pipeline data were Penn Well Mapsearch, MMS, National Pipeline Mapping System, and the

> Geological Survey of Louisiana pipeline datasets. Additionally, based on USGS 1978 habitat data, approximately 56 percent of the length of pipelines crossed marsh habitat and 44 percent crossed upland habitat. Using USGS landloss data from 1956 to 2002 within a 300-m (984-ft) buffer zone (150 m (492 ft) on each side of the pipeline), the total amount of landloss attributed to OCS pipelines was 34,400 ha (85,968 ac). This number represents 0.04 km^2 (4.00 ha, 9.88 ac) per linear km of pipeline installed. When one divides 34,400 ha by the 46-year period (1956-2002), the loss per year is 746 ha (1,843 ac) for the 8,000 km (4,971 mi) of OCS pipeline. This represents 11.9 percent of the total landloss in the Louisiana pipeline study area. Note that from the period 1990-2002 (based on the preliminary data by USGS), the total landloss due to pipelines for the study area was approximately 25 km^2 (approximately (~) 10 mi^2) or 525 ac/yr, which represents a dramatic decline from the 1956-1978 and 1978-1990 analysis periods (**Table 4-12**). Many of these pipelines were installed prior to the implementation of the NEPA of 1969 and the State of Louisiana's Coastal Permit Program in 1981. Additionally, given the width of the buffer, 300 m (984 ft) versus actual pipeline-canal width, which may be 31-61 m (100-200 ft) wide, an unknown portion of the increase in open water is attributed to other factors unrelated to OCS pipelines. To address this, selected OCS pipelines are being studied in greater detail to ascertain direct and secondary impacts to the extent possible and the information from that analysis will be included in future NEPA documents.

Technologies have been and continue to be developed that decrease the impacts of OCS pipelines on wetlands and associated sensitive habitat. For example, the proposed 30-in Endymion pipeline would deliver crude oil from South Pass Block 89 to the LOOP storage facility near the Clovelly Oil and Gas Field. Based on a review of the data in the COE permit application (No. 20-020-1632), the pipeline construction would have zero impacts to marshes (emergent wetlands) and beaches because the operator is using horizontal, directional (trenchless) drilling techniques to avoid damages to these sensitive habitats. Additionally, the proposed route traverses open water to the extent possible.

Proposed Action Scenario: No new pipeline landfalls or new pipelines in State waters are projected as a result of a proposed action. The four new pipelines projected are expected to tie into existing or proposed pipelines extending into deep water in and near the proposed lease sale area (**Figure 4-3**). It is likely that oil production from a proposed action would be transported through pipelines coming ashore in Louisiana, near Timbalier Bay, Grand Isle, or east of the Mississippi River. Gas production would likely be transported through pipelines coming ashore in Mississippi or Alabama.

Gulfwide OCS Program Scenario: Recently, the trend is for new OCS pipelines to tie into existing systems rather than creating new landfalls. From 2003 to 2042, 23-38 new landfalls are projected as a result of the Gulfwide OCS Program (**Table 4-7**).

4.1.2.1.8. Navigation Channels

The current system of navigation channels around the northern GOM is believed to be generally adequate to accommodate traffic generated by a proposed action and the future Gulfwide OCS Program. Gulf-to-port channels and the GIWW that support the prospective ports are sufficiently deep and wide enough to handle the additional traffic. As exploration and development activities increase on deepwater leases in the GOM (such as those in the proposed lease sale area), vessels with generally deeper drafts and longer ranges would be used as needed to support deepwater activities. Therefore, several OCS-related port channels may be deepened or widened during the life of a proposed action to accommodate deeper draft vessels. Typically, no channel deeper than 8 m would be needed to accommodate these deeper draft vessels.

Proposed Action Scenario: Current navigation channels would not change as a result of a proposed action. In addition, no new navigation channels would be required by a proposed action. Channels associated with the primary and secondary service bases for a proposed action would be used more than other OCS navigation channels.

Gulfwide OCS Program Scenario: A few OCS-related port channels may be deepened or widened during the 2003-2042 period to accommodate deeper draft vessels necessary for deepwater development. The Gulfwide OCS Program would require no new navigation channels.

4.1.2.2. Discharges and Wastes

4.1.2.2.1. Onshore Facility Discharges

The primary onshore facilities that support offshore oil and gas activities include service bases, helicopter hubs at local ports/service bases, construction facilities (platform fabrication yards, pipeyards, shipyards), processing facilities (refineries, gas processing plants, petrochemical plants), and terminals (pipeline shore facilities, barge terminals, tanker port areas). A detailed description of these facilities is given in **Chapter 3.3.5.8.**, OCS-Related Coastal Infrastructure. Water discharges from these facilities are from either point sources, such as a pipe outfall, or nonpoint sources, such as rainfall run-off from paved surfaces. The USEPA regulates point-source discharges as part of NPDES. Facilities are issued individual permits that limit discharges specific to the facility type and the waterbody receiving the discharge. The USEPA is currently assessing methods of regulating nonpoint-source discharges, which are primarily run-off from facilities. Other wastes generated at these facilities are handled by local municipal and solid waste facilities, which are also regulated by USEPA.

4.1.2.2.2. Coastal Service-Vessel Discharges

Operational discharges from vessels include sanitary and domestic waters, bilge waters, and ballast waters. Support-vessel operators servicing the OCS offshore oil and gas industry may still legally discharge oily bilge waters in coastal waters, but they must treat the bilge water to limit its oil content to 15 ppm prior to discharge. Sanitary wastes are treated on-board ships prior to discharge. State and local governments regulate domestic or gray water discharges.

4.1.2.2.3. Offshore Wastes Disposed Onshore

All wastes that are not permitted to be discharged offshore by USEPA must be transported to shore or reinjected downhole. A detailed description of these methods is given in **Chapter 4.1.1.4.**, Operational Waste Discharged Offshore. Drilling muds and cuttings from operations that use OBF cannot be discharged offshore. The USEPA Region 4 (under which the proposed lease sale area falls) does not permit the discharge of cuttings wetted with SBF; an individual permit must be obtained to discharge in Region 4. Region 6 does permit the discharge of cuttings wetted with SBF provided the cuttings meet the criteria outlined in the NPDES general permit (GMG290000) effective February 6, 2002. Drill cuttings contaminated with hydrocarbons from the reservoir fluid must be disposed of onshore. Prior to 1993, an estimated 12 percent of drilling fluids and 2 percent of cuttings failed NPDES compliance criteria for offshore discharge and were required to be reinjected or brought to shore for disposal (USEPA, 1993a and b); these pre-1993 percentages are based on data related to the use of OBF. More recent data is not available; however, the increased use of SBF in deepwater drilling and the discharge of the derived cuttings may result in a decrease in drilling waste brought to shore. Depending on the vessel size used, from 20 to 40 25-bbl cutting boxes of waste and from 2,000 to 25,000 bbl of waste fluids in tanks may be transferred to shore.

The USEPA allows TWC fluids to be commingled with the produced-water stream if the combined produced-water/TWC discharges pass the toxicity test requirements of the NPDES permit. Facilities with less than 10 producing wells may not have enough produced water to be able to effectively commingle the TWC fluids with the produced-water stream to meet NPDES requirements (USEPA, 1993a and b). Analysis of the MMS database shows that about 78 percent of all platform complexes have less than 10 well slots and therefore would probably bring their TWC waste to shore. Spent TWC fluid is stored in tanks on tending workboats or is stored on platforms and later transported to shore on supply boats or workboats. Once onshore, the TWC wastes are transferred to commercial waste-treatment facilities and disposed in commercial disposal wells. Offshore wells are projected to generate an average volume of 200 bbl from either a well treatment or workover job every 4 years. Each new well completion would generate about 150 bbl of completion fluid.

Current USEPA NPDES general permits prohibit operators in the GOM from discharging any produced sands offshore. Cutting boxes (15- to 25-bbl capacities), 55-gallon steel drums, and cone-bottom portable tanks are used to transport the solids to shore via offshore service vessels. Total produced sand from a typical platform is estimated to be 0-35 bbl/day (USEPA, 1993a and b).

4.1.2.2.4. Beached Trash and Debris

Trash lost overboard from OCS platforms and support activities can wash ashore on Gulf coastal lands. However, according to the Ocean Conservancy (formerly the Center for Marine Conservation), beachgoers are a prime source of beach pollution, leaving behind nearly 75 tons of trash per week. Other sources of coastal trash are runoff from storm drains and antiquated storm and sewage systems in older cities. Such systems allow co-mingling and overflow of raw sewage and industrial waste into nearby rivers and coastal areas. Commercial and recreational fishers also produce trash and debris by discarding plastics (e.g., ropes, buoys, fishing line and nets, strapping bands, and sheeting), wood, and metal traps.

The Ocean Conservancy sponsors both international beach cleanups as well as a national marine debris monitoring program. Data from the beach cleanups are shown in **Table 4-13**. The data includes all coastal beaches and adjacent waters. The exact location and source of the trash is unknown.

Some trash items, such as glass, pieces of steel, and drums with chemical or chemical residues, can be a health threat to local water supplies, to beachfront residents, and to users of recreational beaches. Cleanup of OCS trash and debris from coastal beaches adds to operation and maintenance costs for coastal beach and park administrators.

4.1.2.3. Noise

Service-vessel and helicopter traffic is the primary sources of OCS-related noise in coastal regions. Sound generated from these activities is transmitted through both air and water, and may be continuous or transient. The intensity and frequency of the noise emissions are highly variable, both between and among these sources. The level of underwater sound detected depends on receiver depth and aspect, and the strength/frequencies of the noise source. The duration that a passing airborne or surface sound source can be received underwater may be increased in shallow water by multiple reflections (echoes). Service vessels and helicopters (discussed in **Chapters 4.1.1.8.2. and 4.1.1.8.3.**) may add noise to broad areas. Sound generated from service-vessel and helicopter traffic is transient in nature and extremely variable in intensity.

Service vessels transmit noise through both air and water. The primary sources of vessel noise are propeller cavitation, propeller singing, and propulsion; other sources include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake (Richardson et al., 1995). Propeller cavitation is usually the dominant noise source. The intensity of noise from service vessels is roughly related to ship size and speed. Sounds from support boats range from 120 to 160 dB at 400-7,000 Hz (USDOC, NMFS, 1984). Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladen vessels. Noise increases with ship speed; ship speeds are often reduced in restricted coastal waters and navigation channels. During the peak year of activity, a range of 300-500 service-vessel trips is projected to occur annually as a result of a proposed action.

Helicopter sounds contain dominant tones (resulting from rotors) generally below 500 Hz (Richardson et al., 1995). Helicopters often radiate more sound forward than backward, and the underwater noise is generally brief in duration as compared with the duration of audibility in the air. From studies conducted in Alaska, a Bell 212 helicopter was 7-17.5 dB noisier (10-500 Hz band) than a fixed-wing Twin Otter for sounds measured underwater at 3-m and 18-m depths (Patenaude et al., 2002). Water depth and bottom conditions strongly influence the propagation and levels of underwater noise from passing aircraft. Lateral propagation of sound is greater in shallow than in deep water. Interestingly, the amount of sound energy received underwater from a passing aircraft does not depend strongly on aircraft altitude. However, characteristics such as more rapid changes in level, frequency, and direction of sound may increase the prominence of sound low-flying aircraft to marine mammals (Patenaude et al., 2002). Wursig et al. (1998) noted highly variable responses of GOM marine mammals to survey aircraft. Reactions by marine mammals to aircraft are most commonly seen when aircraft are flying less than 500-600 ft. Helicopters, while flying offshore, generally maintain altitudes above 700 ft during transit to and from the working area. During the peak year of activity, a range of 300-400 helicopter trips is projected to occur annually as a result of a proposed action.

4.1.3. Other Cumulative Activities Scenario

4.1.3.1. State Oil and Gas Activities

4.1.3.1.1. Leasing and Production

Louisiana

The Office of Mineral Resources holds regularly scheduled lease sales on the second Wednesday of every month. As in Texas, the State of Louisiana's offshore oil and gas leasing program is conducted on a regular basis irrespective of the Federal OCS mineral leasing program.

In recent years, oil and gas production in the State of Louisiana, as in Texas, has been declining. The MMS projects that the State's offshore production would continue this trend over the analysis period.

Mississippi

The State of Mississippi does not have an offshore oil and gas leasing program. The MMS does not expect the State to institute such a program in the near future.

Alabama

Alabama has no established schedule of lease sales. The limited number of tracts in State waters has resulted in the State not holding regularly scheduled lease sales. The last lease sale was held in 1997. The MMS does not expect the State to institute such a program in the near future.

Florida

The State of Florida has experienced very limited drilling in coastal waters. At present, a moratorium has stopped drilling activity in Florida State waters, and the State has no plans for lease sales in the future. At present, no offshore drilling rigs are operating within the State and there are no plans for future drilling offshore.

4.1.3.1.2. Pipeline Infrastructure for Transporting State-Produced Oil and Gas

The pipeline network in the Gulf Coast States is extensive, and transports both State and OCS production. See **Chapter 3.3.5.9.2.** for a discussion of the existing pipeline infrastructure for transporting State-produced oil and gas.

4.1.3.2. Other Major Offshore Activities

4.1.3.2.1. Dredged Material Disposal

Dredged material is described at 33 CFR 324 as any material excavated or dredged from navigable waters of the United States. According to the USEPA, "virtually all ocean dumping occurring today is dredged material, sediments removed from the bottom of waterbodies in order to maintain navigation channels and berthing areas" (USEPA, 1996).

In response to the Marine Protection, Research, and Sanctuaries Act of 1972, as of February 1996, the USEPA finalized the designation of 27 dredged material disposal sites in the GOM. Another 12 sites in the GOM were considered interim sites pending completion of baseline or trend assessment surveys and then the final designation or termination of use of these sites (40 CFR 228.14). Since then, one interim site was approved on a final basis (40 CFR 228.15). Of the 39 designated and interim sites, 7, 21, and 11sites are located in the EPA, CPA, and WPA, respectively. These sites range in area from 0.5 mi^2 to 9 mi^2 and are all within 20 mi of shore.

The COE issues permits for ocean dumping using USEPA's environmental criteria. These permits are subject to USEPA's concurrence. Under the Clean Water Act, the USEPA requires testing of dredge material prior to its disposal to ensure there are no unacceptable adverse impacts to the marine environment.

According to the COE's Ocean Disposal Database (ODD) more than 655 million m^3 of dredged material were disposed in the GOM from 1976 to 2000, which is an average of 27 million m^3 per year (U.S. Dept. of the Army, COE, 2002). The USEPA, COE, and other interested parties are working to identify appropriate uses for dredged material rather than disposing of the material offshore. These uses may include beach nourishment or wetland habitat development.

A discussion of dredging operations in inland coastal regions around the GOM is presented in **Chapter 4.1.3.3.3.**

4.1.3.2.2. Nonenergy Minerals Program in the Gulf of Mexico

This section discusses the impacts of the acquisition of nonenergy minerals (sand, shale, and gravel) from Federal waters in the EPA. There are many submerged shoals located on the OCS that are expected to be long-term sources of sand (sand borrow sites) for coastal erosion management. This sand is needed because of the general diminishing supply of onshore and nearshore sand. The renourishment cycles for beaches or coastal areas require quantities of sand that are not currently available from State sources. The offshore sites are an environmentally preferable resource because OCS sands generally lie beyond the local wave base and the influence of the nearshore physical regime where long-term dredging can result in adverse changes to the local wave climate and the beach. In addition, the offshore sites could provide compatible sand for immediate/emergency repair of beach and coastal damage from severe coastal storms. The economics of dredging in deeper waters is improving as dredging technology advances.

Sand Resources Programs

The MMS has been developing and procuring contracts to provide needed environmental information regarding environmental management of OCS sand resources. The potential for exploitation of sand resources has grown rapidly in the last several years as similar resources in State waters are being depleted or polluted. Several OCS areas are being examined as possible sources of aggregate for construction purposes. At present, there are no sand leases in the EPA.

In 1999, the study *Environmental Survey of Identified Sand Resource Areas Offshore Alabama* (Byrnes and Hammer, 1999) was published. This survey provided (1) an assessment of the baseline benthic ecological conditions in and around the five previously-identified proposed borrow sites (**Figure 4-4**); (2) evaluated the benthic infauna resident in the five potential borrow sites and assessed the potential effects of offshore dredging activity on these organisms, including an analysis of the potential rate and success of recolonization; (3) developed a schedule of the best and worst times for offshore dredging with regard to transitory pelagic species; (4) evaluated the potential for modification to waves because of offshore dredging within the five proposed sand borrow areas; and (5) evaluated the impacts of offshore dredging and subsequent beach nourishment in terms of potential alteration of sediment transport patterns, sedimentary environments, and impacts to local shoreline processes. The information gathered during this study would likely be used should a decision be made to proceed with the preparation of an EA or an EIS in support of a negotiated agreement with the State of Alabama for access to Federal sand resources. The information gathered during the course of this study would also enable MMS to monitor and assess the potential impacts of offshore dredging activities and to identify ways that dredging operations can be conducted so as to minimize or preclude long-term adverse impacts to the environment.

Another study, *Synthesis of Hard Mineral Resources on the Florida Panhandle Shelf: Spatial Distribution and Subsurface Evaluation* (McBride, 1999), produced regional baseline information on the hard mineral resources, geologic framework, and long-term sediment dynamics of the Florida Panhandle Shelf (Mobile Bay, Alabama, to Choctawhatchee, Florida (**Figure 4-5**)). The study's objectives were to (1) quantify hard mineral resource deposits; (2) establish the regional three-dimensional architecture of hard mineral deposits; (3) produce seafloor elevation models; (4) determine patterns and processes of shelf sediment transport; (5) integrate seafloor elevation models with geologic data to establish form-process relationships; (6) disseminate research results; and (7) incorporate appropriate data on hard minerals into the Louisiana State University (LSU) Coastal Studies Institute's Gulfwide Information System.

The *Wave Climate and Bottom Boundary Layer Dynamics with Implications for Offshore Sand Mining and Barrier Island Replenishment in South-Central Louisiana* (Stone, 2000) study produced measurements of wave characteristics at two locations on Ship Shoal to validate a spectral wave propagation model (STWAVE). The objectives of the study were to (1) obtain direct field measurements of bottom boundary layer hydrodynamic processes and suspended sediment transport; and (2) obtain direct field measurements of temporally and spatially varying directional wave parameters at several locations on Ship Shoal.

Sand sources that are to be used on a continual, multiyear, multiuse basis may require biological/physical monitoring to ensure that long-term adverse impacts to the marine and coastal environment do not occur. However, there exists no standard approach or methodology for properly monitoring the effects of ongoing dredging operations. The recently completed studies, *Development and Design of Biological and Physical Monitoring Protocols to Evaluate the Long-term Impacts of Offshore Dredging Operations on the Marine Environment* (Research Planning, Inc. et al., 2001a) and *Examination of Regional Management Strategies for Federal Offshore Borrow Areas along the United States East and Gulf of Mexico Coasts* (Research Planning, Inc. et al., 2001b), addressed those concerns and issues. In addition, extensive damage to a beach area as the result of a severe storm may necessitate that a sand borrow area be used prior to the completion of the environmental work needed to support decisions on conditions of lease agreements. Therefore, some form of "conditions of approval" or "stipulation(s)" might be necessary if leases are to be issued.

The objectives of the above studies were as follows:

- provide MMS with an appropriate and sound design for a physical/biological monitoring system to evaluate the near-term, long-term, and cumulative effects of using Federal sand borrow areas on the U.S. East and Gulf Coasts;
- examine the feasibility and appropriateness of including Federal, State, and local authorities with an interest in the use of offshore Federal sand in a regional management concept for developing ways to assure and monitor the responsible, environmentally sound, long-term management of Federal offshore sand areas; and
- if, in Year 1 of the study, the study team determines that it is feasible and appropriate to manage Federal offshore sand resources on a regional basis, to develop detailed plans and fully identify the relevant parties by geographic area to meet the needs of Federal, State, and local interests to facilitate the environmentally acceptable and cost-effective near and long-term use of Federal sand borrow areas offshore the U.S. East and Gulf Coasts.

In many cases, physical and biological monitoring of borrow areas may be necessary to preclude adverse impacts to the marine environment. An appropriate "condition of approval" or "stipulation" to support a lease for these areas might be the monitoring of the biological and physical regime during operations to ensure that no adverse impacts are or would occur. The study outlined above would provide a blueprint for these monitoring operations. To date, proposed coastal erosion management projects have been examined on a case-by-case, project-specific basis. These resources must be managed on a long-term, system-wide basis in such a way as to ensure that environmental damage would not occur as a result of continual and prolonged use.

4.1.3.2.3. Marine Transportation

An extensive maritime industry exists in the northern GOM. **Figure 3-12** shows the major ports and domestic waterways in the analysis area, while **Tables 3-33 and 3-34** present the 1999 channel depth, number of trips, and freight traffic of OCS-related waterways. Marine transportation within the analysis area should grow linearly based on historical freight traffic statistics given current conditions. Should any infrastructure changes occur, the marine transportation would reflect these changes. For example, if a port in the analysis area (or outside the analysis area) deepened its channel or constructed new railroads or highways into the port area, then the number of trips and the volume of commodities into and out of the port would change accordingly. Or if a refinery near one of the ports were to close, then tanker traffic to that port may decrease.

Tanker imports and exports of crude and petroleum products into the GOM are projected to increase (USDOE, EIA, 2001a). In 2000, approximately 2.08 BBO of crude oil (38% of U.S. total) and 1.09 BBO of petroleum products (13% of U.S. total) moved through analysis area ports. By the year 2020, these volumes are projected to grow to 2.79 BBO of crude oil and 1.77 BBO of petroleum products. Crude oil would continue to be tankered into the GOM for refining from Alaska, California, and the Atlantic.

Proposed Action Scenario: Marine transportation is not expected to change as a result of a proposed action.

Gulfwide OCS Program Scenario: Gulfwide OCS Program activities over the 2003-2042 period are not expected to change marine transportation. The number of trips and volume of commodities into and out of analysis area ports are expected to grow linearly based on historical freight traffic statistics.

4.1.3.2.4. Military Activities

The air space over the GOM is used extensively by DOD for conducting various air-to-air and air-to-surface operations. Eleven military warning areas and six water test areas are located within the GOM (**Figure 2-1**). These warning and water test areas are multiple-use areas where military operations and oil and gas development have coexisted without conflict for many years.

The EPA has five designated military warning areas that are used for military operations. These areas total approximately 34.1 million ac. Portions of Eglin Water Test Areas (EWTA) comprise an additional 33.6 million ac in the EPA. The total 67.7 million ac is about 89 percent of the area of the EPA.

The entire proposed lease sale area (1.5 million ac) is within either a military warning area or an EWTA. The northeastern corner of the proposed lease sale area is in Military Warning Area 155. Portions of this military warning area comprise 0.9 million ac of the northeastern corner of the proposed lease sale area. Portions of EWTA 1 and 3 comprise the remaining 94 percent (1.4 million ac) of the proposed lease sale area.

The Navy uses the GOM waters for shakedown cruises for newly-built ships, for ships completing overhaul or extensive repair work in GOM shipyards such as Pascagoula, Mississippi, and for various types of training operations. While no aircraft carriers are currently home-ported in the GOM, carriers may from time-to-time conduct flight operations in the GOM. No areas in the GOM have been designated as Naval operating areas requiring restrictions on the navigation of other vessels.

Future uses of the Eastern GOM by the military are uncertain at present, but activities are expected to increase rather than decrease. The new F-22 fighter aircraft may be based at Eglin or Tyndall Air Force Bases in Florida, and a new generation of theater missile defense weapons systems may require the large air and water spaces of the Eastern GOM for development and testing. The Eastern GOM is the largest area of the continental U.S. in which long-range systems can be deployed. Using areas outside the U.S., such as Pacific Ocean ranges, would increase costs and decrease flexibility tremendously.

The DOD reviewed the proposed lease sale area prior to Lease Sale 181 in December 2001 with both current and future military requirements in mind and determined at that time that future lease sales in this reduced area would not interfere with current and future military uses provided that certain operational restrictions be placed on any leases resulting from such lease sales (**Chapter 2.3.1.3.1.**, Military Warning Areas Stipulations – Hold and Save Harmless, Electromagnetic Emissions, and Operational Restrictions).

4.1.3.3. Other Major Influencing Factors on Coastal Environments

4.1.3.3.1. Submergence of Wetlands

Submergence of wetlands along the Gulf Coast is primarily caused by (1) eustatic sea-level rise – a reduction in the volume of water stored in polar ice caps, and (2) land subsidence – caused by various localized natural and manmade events such as down-warping or horizontal movement of the earth's crust, weighted surface compression; and oxidation, consolidation, settling, and dewatering of surface sediments (Swanson and Thurlow, 1973). In localized areas, subsidence and sea-level rise can be offset by sedimentation, placement of dredged material, and peat formation. Peat formation (horizons) refers to the soil material deposited in deep water that are highly colloidal in nature, as well as compact and rubbery (Nyle, 1990). Radiocarbon dating peat horizons is used to identify long-term (greater than 100 years) average rates and patterns of subsidence along coastal Louisiana. Using conventional radiocarbon age, depth, and below current sea-level relationships, subsidence rates are easily calculated (Kulp and Howell, 2001).

During this century, the rate of eustatic sea-level rise along the Louisiana coast has been relatively constant at 2.3 millimeters (mm) per year (yr) (23 cm/century), although the rate has varied from a sea-level decrease of 3 mm/yr to a maximum increase of 10 mm/yr over decade-long periods (Turner and Cahoon, 1988). Submergence in the GOM is occurring most rapidly along the Louisiana coast and more slowly in other coastal states. Depending on local geologic conditions, the subsidence rate varies across coastal Louisiana from 3 to 10 mm/yr. One of the major factors causing greater submergence rates in Louisiana is reduced sedimentation, resulting from deltaic abandonment, flood control, and channelization of the Mississippi River.

Fluid withdrawal can cause localized subsidence above the producing reservoirs. In coastal Louisiana, about 400 km^2 of wetlands have a subsidence potential greater than 10 cm because of fluid withdrawal (Turner and Cahoon, 1988).

4.1.3.3.2. River Development and Flood Control Projects

In recent decades, alterations in the upstream hydrology of the rivers draining into the northern GOM have resulted in various coastal impacts. Dams and reservoirs on upstream tributaries trap much of the sediment load in the rivers. The suspended sediment load of the Mississippi River has decreased nearly 60 percent since the 1950's, largely as a result of dam and reservoir construction upstream (Tuttle and Combe, 1981; Turner and Cahoon, 1988).

In a natural system, over-bank flooding introduces sediments into adjoining wetlands. Flood control on the Mississippi and other rivers has largely eliminated flood-borne sedimentation in the GOM coastal wetlands, contributing to their deterioration.

Channelization of the Mississippi and other rivers in conjunction with flood control levees has also contributed to wetland loss and has interrupted wetland creation around the GOM by preventing distribution of alluvial sediments across deltas and flood plains. Prior to channelization, the flow of rivers was distributed among several distributary channels that delivered sediment over a broad area during high river stages. Today, sediment from the Mississippi River is primarily discharged through the main channel directly to the deep waters of the continental slope. The only significant exception to this scenario is the diversion of approximately 30 percent of the Mississippi River flow to the Atchafalaya River; this diversion does not capture 30 percent of the sediment flow, however, because most of the sediment is restricted to the deeper river channel.

4.1.3.3.3. Dredging

Dredging operations include sediment and gravel harvesting; pipeline installation; canal installation, maintenance, and modifications; harbor installation and maintenance; and stream channelization.

Numerous channels are maintained throughout the onshore cumulative activity area by Federal, State, county, commercial, and private interests. Proposals for new and maintenance dredging projects are reviewed by Federal, State, and county agencies as well as by private and commercial interests to identify and mitigate adverse impacts upon social, economic, and environmental resources.

Typically, the USCOE schedules surveys every two years on each navigation channel under its responsibility to determine the need for maintenance dredging. Maintenance dredging is then performed on an as-needed basis. Dredging cycles (1-6 years) vary broadly from channel to channel and channel segment to channel segment. The USCOE is charged with maintaining all larger navigation channels in the cumulative activity area. The USCOE dredges millions of cubic meters of dredged material per year in the cumulative activity area. Some shallower port-access channels may be deepened over the next 10 years to accommodate deeper draft vessels.

Materials from maintenance dredging are primarily disposed of on existing dredged-material disposal banks and in dredged-material disposal areas. Additional dredged-material disposal areas for maintenance or new-project dredging are developed as needed and must be evaluated and permitted by the USCOE and relevant State agencies prior to construction. Some dredged sediments are dispersed into offshore waters at established disposal sites.

When placing the material on a typical dredged material disposal site, the usual fluid nature of the mud and subsequent erosion causes widening of the site, which may bury adjacent wetlands, submerged vegetation, or nonvegetated water bottoms. Consequently, adjacent soil surfaces may be elevated, converting wetlands to uplands, fringes of shallow waterbodies to wetlands, and some nonvegetated water bottoms to shallower water bottoms or emergent areas that may become vegetated due to increased light at the new soil surface.

Dredged materials from channels are often contaminated with toxic heavy metals, organic chemicals, pesticides, oil and grease, and other pollutants originating from municipal, industrial, and vessel discharges and nonpoint sources, and can result in contamination of areas formerly isolated from major anthropogenic sources (USEPA, 1979). The vicinities around harbors and industrial sites are most noted for this problem. Hence, sediment discharges from dredging operations can be major point sources of pollution in coastal waters in and around the GOM. In addition, inland and shallow offshore disposal can change the navigability and natural flow or circulation of waterbodies.

In 1989, USEPA estimated that more than 90 percent of the volume of material dumped in the oceans around the U.S. consisted of sediments dredged from U.S. harbors and channels (USEPA, 1989). As of February 1997, in response to the Marine Protection, Research, and Sanctuaries Act of 1972, USEPA had finalized the designation of eight dredged-material disposal sites in the cumulative activity area. Another four sites in the GOM are considered interim sites for dredged-material disposal. These sites primarily facilitate the COE's bar-channel dredging program. Generally, each bar channel of navigation channels connecting the GOM and inland regions has 1-3 disposal sites used for disposal of maintenance dredged material. These are usually located in State waters. Some designated sites have never been used.

Installation and maintenance of any navigation channel and many pipeline canals connecting two or more waterbodies changes the hydrodynamics in their vicinity. These changes are typically associated with saltwater intrusion, reduced freshwater retention, changed circulation patterns, changed flow velocities, and erosion. When these channels are permitted for construction through sensitive wetland habitats or when sites are permitted for dredged-material disposal, measures are required to mitigate unavoidable adverse environmental impacts. Structures constructed to mitigate adverse hydrodynamic impacts and accelerated erosion include dams, weirs, bulkheads, rip-rap, shell/gravel mats, and gobi mats.

Generally, little or no maintenance is performed on mitigation structures. Therefore, many mitigation facilities, particularly in regions where the soil is poorly consolidated and has a high organic content, are known to become ineffective within a few years of construction. The number of mitigation structures associated with navigation and pipeline channels is unknown.

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

Petroleum hydrocarbons can enter the GOM from a number of sources. These sources include both natural geochemical processes and onshore and offshore activities of man. Major sources of petroleum hydrocarbon inputs to GOM waters include, in order of the greatest source to the least source are as follows: (1) municipal wastewater discharges; (2) natural seepage; (3) spills; (4) Mississippi River runoff; (5) nonpoint-source urban runoff; (6) industrial wastewater discharges; and (7) produced water from offshore oil production. Numerical estimates of the relative contribution of these sources to oil inputs in the GOM are presented in **Table 4-14**. Although the GOM comprises one of the world's most prolific offshore oil-producing provinces as well as having heavily traveled tanker routes, inputs of petroleum from onshore sources far outweigh the contribution from offshore activities. Man's use of petroleum hydrocarbons is generally concentrated in major municipal and industrial areas situated along coasts or large rivers that empty into coastal waters.

The following paragraphs provide a description of these oil input sources.

4.1.3.4.1. Municipal Wastewater Discharges

Significant amounts of petroleum hydrocarbons end up in the wastewaters of cities from a variety of sources, especially the operation of motor vehicles. The actual amount of petroleum hydrocarbons discharged at municipal plants depends on the level of treatment, and plant design and operation. It is assumed that all municipalities along the Gulf Coast use primary treatment. Even considering this, MMS estimates that the discharge of wastewaters from municipalities located in the coastal zone of the GOM contribute the largest amount of oil and grease to GOM waters (0.35 million metric tons annually (Mta)).

4.1.3.4.2. Natural Seepage

Based on geologic potential, Wilson et al. (1973) estimated that the U.S. and Mexican Gulf areas could be seeping as much as 204,000 bbl of oil per year (0.027 Mta) (**Table 4-14**). Twenty years later, MacDonald et al. (1993) estimated the volume of natural seepage for an area of the continental slope off Louisiana by using satellite imagery. He estimated a natural seepage rate of about 120,000 bbl per year (0.016 Mta) from a 23,000-km^2 area. Given that MacDonald's estimate would be a significant subset of Wilson's estimate, Wilson's estimate appears to be within reason and is still used.

4.1.3.4.3. Spills

Oil spills can happen from a large variety of sources, including tankers, barges, other vessels, pipelines, storage tanks and facilities, production wells, and mystery sources. **Table 4-14** shows the relative contribution of spills to the overall input of oil to the GOM. This amount is far less than what is contributed by wastewater and seeps. The total contribution of petroleum inputs to GOM waters from spills is estimated to be about 80,000 bbl per year or 0.011 Mta (**Table 4-14**). The projected contribution from non-OCS-related spills (0.0096 Mta) is approximately an order of magnitude greater than the amount projected to be spilled annually from OCS-related spills (0.0013 Mta). **Table 4-15**, discussed in **Chapter 4.3.1.**, Oil Spills, provides the estimated future annual contribution of the various sources. **Chapter 4.3.1.** also summarizes estimates of spills that could occur as a result of a proposed action.

4.1.3.4.4. Mississippi River Runoff

The Mississippi River carries large quantities of petroleum hydrocarbons into GOM waters from land-based drainage that occurs far upriver but that eventually reaches the Mississippi River or its tributaries. The GOM sediment samples collected within a broad crescent around the Mississippi River show petroleum contamination from the River's discharge (Bedding, 1981; Brooks and Giammona, 1988). Although the hydrocarbon burden measured at the mouth of the Mississippi River is also from coastal inputs, MMS's estimates found in **Table 4-14** only includes the amount of hydrocarbons in the Mississippi River outfall that would be contributed upriver from New Orleans.

4.1.3.4.5. Nonpoint-Source Urban Runoff

Significant volumes of petroleum hydrocarbons are deposited in urban areas from a variety of sources: asphaltic roads; the protective asphaltic coatings used for roofs, pipes, etc.; oil used in two-cycle engines such as outboard boat motors and lawn equipment; gas station runoff; and unburned hydrocarbons in car exhaust. These sources are either directly flushed by rainfall and runoff into storm drains and into coastal waters or rivers, or are weathered, broken down, and then dispersed. The Automotive Information Council estimated in 1990 that 8.3 MMbbl (approximately 1.2 Mta) of used motor oil waste is generated annually in the U.S. by do-it-yourselfers (Automotive Information Council, 1990). They estimate that 60 percent of this is poured on the ground, thereby adding 5.7 MMbbl of oil to the urban environment annually (0.814 Mta). Much of this discarded oil contributes to the petroleum loading found in municipal wastewater and urban runoff.

4.1.3.4.6. Industrial Wastewater Discharges

Coastal Refineries: Other major land-based sources of petroleum hydrocarbons in GOM waters include refineries and other industry effluents. **Chapter 3.3.5.8.5.**, Processing Facilities, describes the extensive refinery operations occurring along the Gulf Coast.

Non-Refinery Industrial Discharges: The MMS estimates that wastewaters from industries located along the GOM's coastal zone, including those located in the southern Mississippi River industrial corridor, contribute about 0.004 Mta. Many of the other industries operating in the Gulf Coast area support the oil and gas industry and are described in **Chapter 3.3.5.8.**, OCS-Related Coastal Infrastructure. **Chapter 3.3.5.1.2.**, Land Use, also provides an overview of the other major Gulf Coast industries.

4.1.3.4.7. Produced Water

The OCS operations routinely discharge small amounts of oil in wastewater discharges, primarily in produced waters. Produced water, when discharged overboard (after treatment that removes the majority of the entrained oil content), is limited by the USEPA effluent limitation guidelines to a monthly average of 29 mg/l oil content (USEPA, 1993). A typical annual amount of OCS-produced water to be discharged in the future was estimated based on annual historical quantities reported to MMS for the last 6 years **Chapter 4.1.1.4.2.**, Produced Waters). The average annual value of 532 MMbbl per year was converted to liters than multiplied by the monthly average oil and grease (29 mg/l) to estimate the contribution to the petroleum levels in GOM waters from OCS discharged produced waters. This calculation results in an estimate of 0.002 Mta of petroleum hydrocarbons entering GOM waters from operational, OCS produced-water discharges (**Table 4-14**).

4.1.3.4.8. Other Sources

There are other sources of petroleum hydrocarbons not estimated in this exercise and, therefore, a complete mass balance cannot be done. For example, vessel operational discharges have changed due to new regulations. In 1985, operational discharges (bilge and ballast water and oily tank wastes) from vessels dominated the major sources of oil inputs. Since then, the MARPOL regulations have significantly reduced the levels of operational discharges associated with vessel operations. Terminals are now required to maintain onshore disposal facilities for receipt of this waste; although full compliance with these requirements is not yet attained. At this time, a review of the effectiveness of the more restrictive discharge requirements is still ongoing, so no new numbers are available to estimate vessel contributions. The MMS expects that National Academy of Science's 1985 projection, 47 percent of the amount of oil entering the world ocean is from operational discharges from vessels, to be reduced significantly when they publish their updated projections. Other minor inputs from erosion of sedimentary rocks, atmospheric inputs, and dredged material disposal are not quantified. The contribution from international petroleum sources, such as Mexico and Cuba, was not calculated.

4.2. ENVIRONMENTAL AND SOCIOECONOMIC IMPACTS - ROUTINE OPERATIONS

4.2.1. Alternative A – The Proposed Actions

The proposed actions are proposed Lease Sales 189 and 197. The lease sales are scheduled to be held in December 2003 and March 2005, respectively. Each lease sale would offer for lease all unleased blocks in the proposed lease sale area in the EPA. It is estimated that each proposed lease sale could result in the discovery and production of 0.065-0.085 BBO and 0.265-0.340 Tcf of gas during the period 2003-2042. A description of the proposed actions is included in **Chapter 1.2.** Alternatives to the proposed actions and mitigating measures are also described in **Chapters 2.3.2. and 2.3.1.3.**, respectively.

The analyses of the potential impacts are based on a scenario for a typical proposed action. These scenarios provide assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenarios and major impact-producing factors from routine activities associated with a proposed action is included in **Chapter 4.1.** The two proposed mitigating measures (Marine Protected Species and Military Areas Stipulations) are considered part of the proposed action(s) for analysis purposes.

The scenario and analysis of potential impacts of oil spills and other accidental events are discussed in **Chapter 4.3.** The Gulfwide OCS Program and cumulative scenarios are discussed in **Chapter 4.1.** The cumulative impact analysis is presented in **Chapter 4.5.**

4.2.1.1. Impacts on Air Quality

The following activities potentially degrade air quality: platform construction and emplacement; platform operations; drilling activities; flaring and burning; survey and support vessel operations; pipeline laying operations; evaporation of volatile petroleum hydrocarbons during transfers and from surface oil slicks; and fugitive emissions. Supporting materials and discussions are presented in **Chapter 3.1.1.** (Air Quality), **Appendix A.3.** (Meteorological Conditions), **Chapter 4.1.1.9.** (Hydrogen Sulfide and Sulfurous Petroleum), and **Chapter 4.1.1.6.** (Air Emissions). The parameters of this analysis are emission rates, surface winds, atmospheric stability, and mixing height.

Emissions of certain air pollutants are known to be detrimental to public health and welfare. Some of these pollutants are directly emitted into the air, while others are formed in the atmosphere through chemical reactions. Nitric oxide and NO_2 constitute NO_x emissions. Nitrogen dioxide, a by-product of all combustion processes, is emitted from sources such as internal combustion engines, natural gas burners, and flares. Nitrogen dioxide is a precursor pollutant involved in photochemical reactions that yield ozone. Nitrogen dioxide is an irritating gas that may increase susceptibility to infection and may constrict the airways of people with respiratory problems. Further, nitrogen dioxide can react with water to form nitric acid, which is harmful to vegetation and materials, as a result of increased acidity in precipitation.

Carbon monoxide is a by-product of incomplete combustion and is primarily contained in engine exhaust. Carbon monoxide is readily absorbed into the body through the lungs, where it reacts with hemoglobin in the blood reducing the transfer of oxygen within the body. Carbon monoxideparticularly affects people with cardiovascular and chronic lung diseases.

Sulfur dioxide may cause constriction of the airways and particularly affects individuals with respiratory diseases. Sulfur dioxide can combine with water and oxygen, thus increasing the acidity in precipitation, which can be harmful to vegetation and materials. The flaring of H_2S, which is found naturally occurring in "sour" gas and the burning of liquid hydrocarbons, results in the formation of SO_2. The amount of SO_2 produced is directly proportional to the sulfur content of the hydrocarbons being flared or burned. The concentration of the H_2S varies substantially from hydrocarbon reservoir to reservoir, and even varies to some degree within the same reservoir. Flaring or burning of sour production is also of concern because it could significantly impact onshore areas, particularly when considering the short duration averaging periods (3 and 24 hr) for SO_2. The combustion of liquid fuels is the primary source of sulfur oxides (SO_x) when considering the annual averaging period.

Impacts from cleanup operations on high-rate wells can be significant. To prevent inadvertently exceeding established criteria for SO_2 for the 3-hr and 24-hr averaging periods, all incinerating events involving H_2S or liquid hydrocarbons are evaluated individually during the MMS review process for OCS plans.

Volatile organic compounds are precursor pollutants involved in a complex photochemical reaction with NO_x in the atmosphere to produce ozone. The primary sources of VOC's are venting and evaporative losses that occur during the processing and transporting of natural gas and petroleum products. A more concentrated source of VOC's comes from glycol dehydrator still vents.

Particulate matter is comprised of finely divided solids or liquids such as dust, soot, fumes, and aerosols. PM_{10} particles are small enough to bypass the human body's natural filtration system and can be deeply inhaled into the lungs, affecting respiratory functions. PM_{10} can also affect visibility, primarily by scattering of light by particles, and by light absorption to a lesser extent. This analysis considers mainly PM_{10} matter.

Ozone is a nearly colorless gas with a faint but distinctive odor, somewhat similar to chlorine. It is formed in the atmosphere from complex chemical reactions involving hydrocarbons and nitrogen oxides in the presence of sunlight. At ground level, ozone can cause or aggravate respiratory problems, interfere with photosynthesis, and can damage vegetation and crack rubber. Children, the elderly, and healthy people who exercise strenuously outdoors are +particularly sensitive to ozone concentrations. In the upper atmosphere, ozone is essential to life as we know it. The upper ozone layer shields the Earth's surface from harmful ultraviolet radiation. Depletion of the upper ozone layer is one of the most complex environmental issues facing the world today. This analysis would not include impacts on upper atmospheric ozone.

Emissions of air pollutants would occur during exploration, development, and production activities. Typical emissions for OCS exploratory and development drilling activities presented in **Chapter 4.1.1.6.** show that emissions of NO_x are the primary pollutant of concern. These emission estimates are based on a drilling scenario of a 4,115-m hole during exploration activities and a 3,050-m hole during development activities. Emissions during exploration drilling are higher than emissions during development drilling due to increased power requirements and the longer time required for drilling a deeper hole.

Platform emission rates for the GOM Region (**Chapter 4.1.1.6.**) are provided from the 1992 emission inventory of OCS sources compiled by MMS (Steiner et al., 1994). The primary pollutants of concern are NO_x and VOC, both considered precursors to ozone. Emission factors for other activities, such as support vessels, helicopters, tankers, and loading and transit operations, were obtained from Jacobs Engineering Group, Inc. (1989) and USEPA AP-42 (1985).

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.

Proposed Action Analysis

The total OCS emissions (over the life of a proposed action) for the criteria pollutants are indicated in **Table 4-16**. NO_x is the major emittent, while PM_{10} is the least emitted pollutant. Combustion intensive operations such as platform operations, well drilling, and service-vessel activities contribute mostly NO_x; platform operations are also the major contributors of VOC emissions. Platform construction emissions contribute appreciable amounts of all pollutants over the life of a proposed action. These emissions are temporary in nature and generally occur for a period of 3-4 months. Typical construction emissions result from the derrick barge placing the jacket and various modular components and from various service vessels supporting this operation. Exploratory wells and developmental wells contribute considerable amounts of all pollutants. Well emissions are temporary in nature and typically occur over a 100-day drilling period. Support for OCS activities includes crew and supply boats, helicopters, and pipeline vessels; emissions from these sources consist mainly of NO_x and CO. These emissions are directly proportional to the number and type of OCS operations requiring support activities. Most support emissions occur during transit between port and offshore oil and gas development activities, while a smaller percentage result from idling at the platform. Platform and well emissions were calculated using the integration of projected well and platform activities over time.

Projected total emissions for each offshore subarea due to a proposed action are presented in **Table 4-17**. Pollutants are distributed to subareas proportional to the projected number of wells and production structure installations slated for those areas.

The total pollutant emissions per year are not uniform. During the early years of a proposed action, emissions would be small and would increase over time with full platform emplacements and production. After reaching a maximum, emissions would decrease as all platforms and wells are removed and service-vessel trips and other related activities are no longer needed.

The peak-year emissions in tons per year for the criteria pollutants are indicated in **Table 4-18**. The peak-year emissions for a proposed action are projected to occur 7 years after the proposed lease sale. The peak emissions are calculated by combining peak-year activity total emissions for exploratory wells, development wells, and platforms over the life of a proposed action, and superimposing peak projected activity for support vessels and other emissions onto that peak year. Well drilling activities and platform peak emissions are not necessarily simultaneous. However, it is assumed for this analysis that total well and platform peak-year emissions combined with vessels and other emissions occur simultaneously. Use of the peak emissions shall provide the most conservative estimates of potential impacts to onshore air quality. NO_x is the main pollutant emitted, with service vessels being the primary source.

To provide the most conservative estimation, it is assumed that emissions from a potential oil spill and a potential blowout both occur in the peak year.

Projected peak emissions for each offshore subarea due to a proposed action are presented in **Table 4-19**. Pollutants are distributed to subareas proportional to the number of production structure installations projected for those areas.

The MMS regulations (30 CFR 250.303-304) do not establish annual significance levels for CO and VOC for the OCS areas under MMS jurisdiction. For CO, a comparison of the projected emission rate to the MMS exemption level would be used to assess impacts. The formula to compute the emission rate in tons/yr for CO is $3{,}400 \cdot D^{2/3}$; D represents distance in statute miles from the shoreline to the source. This formula is applied to each facility. The CO exempt emission level is 7,072 tons/yr at the State boundary line of 3 mi, which is greater than CO peak emissions from a proposed action.

The VOC emissions are best addressed as their corresponding ozone impacts, which were studied in the Gulf of Mexico Air Quality Study (GMAQS). The GMAQS indicated that OCS activities have little impact on ozone exceedance episodes in coastal nonattainment areas. Total OCS contributions to the exceedance (greater than 120 ppb) episodes studied were less than 2 ppb. In the GMAQS, the model was also run using double emissions from OCS petroleum production activities associated with offshore facilities and the resulting attributable ozone concentrations, during modeling exceedance episodes, were still small, ranging 2-4 ppb. The activities under a proposed action would not result in a doubling of the emissions and because the proposed activities are substantially smaller than this worst-case scenario, it is logical to conclude that their impact would be substantially smaller as well (Systems Applications International et al., 1995).

It is projected that all of the gas and oil produced as a result of a proposed action would be piped to shore terminals. Thus, no fugitive emissions associated with tanker and barge loadings and transfer are expected.

The Breton National Wilderness Area is a Class I air quality area administered by FWS (**Figure 3-2**). Under the Clean Air Act, MMS would notify the National Park Service and FWS if emissions from proposed projects may impact the Breton Class I area. Mitigating measures, including low sulphur diesel fuels and stricter air emissions monitoring and reporting requirements, are required for sources that are located within 100 km of the Breton Class I Area and that exceed emission levels agreed upon by the administering agencies.

The MMS studied the impacts of offshore emissions using the OCD model. Modeling was performed using OCD version 5. Three years of meteorological data (i.e., 1992, 1993, and 1994) were used. Over-water data are from Buoy 42007, onshore meteorology from the New Orleans NWS station, and upper air data from the Slidell, Louisiana, radiosonde station. Default values of 500 m for the mixing height and 80 percent for the relative humidity were used for the over-water meteorological data. Receptors were set at Breton Island, along the coastline, and also a short distance inland in order to capture coastal fumigation. The receptor at Breton Island (**Figure 3-2**) was chosen to represent the Class I area. For the Class I and Class II areas (all areas exclusive of the Class I area), the calculated concentrations are reported in **Tables 4-20 and 4-21** and are compared with the maximum allowable concentration increases, as regulated by 30 CFR 250.45(g) and 40 CFR 51.166(c).

Tables 4-20 and 4-21 list the predicted contributions to onshore pollutant concentrations from activities associated with the proposed lease sale (including all phases of activities, i.e., exploration, development, and production) and compares them with the maximum allowable increases over a baseline concentration established under the air quality regulations. While the tables show that the proposed lease sale by itself would result in concentration increases that are well within the maximum allowable limits for Class I and Class II areas, a direct comparison between the two sets of figures is not possible. This is because the actual maximum allowable increase depends on the net change in emissions from all other sources in the area, both offshore and onshore, since the date the baseline level was established. Sources that were already in place at the applicable baseline date are included in the establishment of the baseline and corresponding concentration and do not count in the determination of the maximum allowable increment. The PM_{10} are emitted at a substantially smaller rate than NO_2 and SO_2 and, hence, impacts from PM_{10} would be expected to be even smaller since chemical decay was not considered in this plume dispersion model.

Suspended particulate matter is important because of its potential in degrading the visibility in national wildlife refuges or recreational parks designated as PSD Class I areas. The impact depends on emission rates and particle size. Particle size represents the equivalent diameter, which is the diameter of a sphere that would have the same settling velocity as the particle. Particle distribution in the atmosphere has been characterized as being largely trimodal (Godish, 1991), with two peaks located at diameters smaller than 2 m and a third peak with diameters larger than 2 m. Particles with diameters of 2 m or larger settle very close to the source (residence time of approximately ½ day) (Lyons and Scott, 1990). For particles smaller than 2 m, which do not settle fast, wind transport determines their impacts. Projected PM_{10} concentrations are expected to have a low impact on the visibility of PSD Class I areas.

Summary and Conclusion

Emissions of pollutants into the atmosphere from the activities associated with a proposed action are not expected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emission heights, emission rates, and the distance of these emissions from the coastline. Emissions from proposed action activities are not expected to have concentrations that would change onshore air quality classifications. Increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} are estimated to be less than the maximum increases allowed under the PSD program.

4.2.1.2. Impacts on Water Quality

Activities that are projected to result from a proposed lease sale are given in **Tables 4-8(a) and 4-8(b)**. The routine activities that would impact water quality include the following:

- discharges during drilling of exploration and development wells;
- workover of a well;
- structure installation and removal;
- discharges during production;
- installation of pipelines;
- service vessel discharges; and
- nonpoint-source runoff.

4.2.1.2.1. Coastal Waters

Proposed Action Analysis

In coastal waters, the water quality would be impacted by the discharges from the service vessels in port. The types of discharges and regulations were discussed in **Chapters 4.1.1.4.8. and 4.1.2.2.2.** Most discharges are treated prior to release, with the exception of ballast water. In coastal waters, bilge water may be discharged with an oil content of 15 ppm or less. The discharges would affect the water quality locally. Estimates of the volume of bilge water that may be discharged are not available.

Supporting infrastructures discharge into local waterways during routine operations. The types of onshore facilities were discussed in **Chapter 4.1.2.2.2.** All point-source discharges are regulated by the USEPA, which is the agency responsible for coastal water quality. The USEPA NPDES storm water effluent limitations control storm water discharges from support facilities. Nonpoint-source runoff, such as rainfall, which has drained from a public road, may contribute hydrocarbon and trace-metal pollutants. Data are not available to make estimates of the impact from this type of discharge.

Summary and Conclusion

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

4.2.1.2.2. Marine Waters

Proposed Action Analysis

Drilling Muds and Cuttings

The drilling of exploratory and development wells results in the discharges of drilling fluids, called "muds," and cuttings. The USEPA NPDES permits restrict the type and amount of mud and cuttings that can be discharged. In the Eastern GOM, USEPA Region 4, WBF and cuttings can be discharged; OBF and cuttings and SBF and cuttings cannot be discharged.

Tables 4-8 (a) and (b) show the calculated average volumes of drilling fluids and cuttings generated drilling a typical shallow and deep exploration well, respectively, in the EPA. It is assumed that the shallow and deep wells are drilled using treated seawater and/or WBF and SBF (Richardson and Trocquet, personal communication, 2002). Although the discharge of SBF adhered to cuttings is not currently permitted, the volume of SBF and SBF cuttings is included in **Tables 4-8 (a) and (b)** for informational purposes. The MMS estimates that a proposed action would result in 11-13 exploratory and delineation wells and 19-27 development wells being drilled over 37 years.

The drilling of a single exploratory well in the EPA would result in the discharge of 2,300-2,720 bbl of WBF cuttings, depending upon the well depth (**Tables 4-8(a) and 4-8(b)**). The drilling of the proposed 11-13 exploration and delineation wells would generate 25,000-35,500 bbl of WBF cuttings. The drilling of a single development well would generate 1,000-1,225 bbl of WBF cuttings. The drilling of 19-27 development wells would generate 19,000-33,000 bbl of WBF cuttings.

The fate and effects of WBF have been extensively studied throughout the world (Engelhardt et al., 1989). The primary environmental concerns associated with WBF are the increased turbidity in the water column, alteration of sediment characteristics because of the addition of coarse material in cuttings, and trace metals. Occasionally, formation fluids may be discharged with the cuttings, adding hydrocarbon contamination, which may require treatment before discharge. The WBF are rapidly dispersed in the water column immediately after discharge, and the solids descend to the seafloor (Neff, 1987). The greatest effects to the benthos are within 100-200 m, primarily due to the increased coarsening of the sediment by cuttings. Most of the components of the WBF have low toxicity with the exception of some trace metals. Barium is the major element in the mud because of the high barite level, but trace amounts of chromium, copper, cadmium, mercury, lead, and zinc are also present. The trace mercury concentrations in barite are bound in sulfur compounds and not available for biological methylation or subsequent bioconcentration (Trefrey, et al., 1986). Significant elevations of all these metals except chromium were observed within 500 m of six GOM drilling sites on the continental shelf (Boothe and Presley, 1989). The USEPA guidelines limit the levels of cadmium and mercury in stock barite to 3.0 mg per kilogram (kg) and 1.0 mg/kg (dry weight), respectively. A study of chronic impacts from oil and gas activities (Kennicutt, 1995) determined that metals from discharges, including mercury and cadmium, were localized to within 150 m of the structure. Highest levels of metal contaminants were attributed to a platform where discharges are shunted to within 10 m of the bottom.

A recent literature review (Neff et al., 2000) discusses the current knowledge about the fate and effects of SBF on the seabed. Like OBF, the SBF do not disperse in the water column and therefore are not expected to adversely affect water quality. The SBF settle very close to the discharge point, thus affecting the local sediments. Unlike OBF, the SBF do not typically contain toxic aromatic compounds. The primary affects are smothering of benthic organisms, alteration of sediment grain size, and addition of organic matter, which can result in localized anoxia while the SBF degrade. Different formulations of SBF use different base fluids that degrade at different rates, thus affecting the impact. Bioaccumulation tests also indicate that SBF and their degradation products should not significantly bioaccumulate. It is expected that discharged cuttings should degrade within 2-3 years after cessation of discharge. The MMS is currently jointly funding a study of the spatial and temporal effects of discharged WBF, SBF and drill cuttings to evaluate the effects.

The February 2002, USEPA, Region 6 permit modifications describe the additional limits and monitoring requirements used to control potential environmental impacts of cuttings discharges with adhered SBF. The additional requirements include sediment toxicity testing of the SBF stock base fluid and the relative sediment toxicity of the SBF adhered to cuttings. The biodegradation rate, measured by gas production, of the SBF stock base fluid and SBF adhered to cuttings has also been added to the

USEPA Region 6 general permit. Additionally, a limit has been set on the concentration of PAH's in the stock base fluid and the percent of SBF retained on the cuttings (USEPA, 2002).

Produced Water

During production, produced water is the primary discharge and would impact water quality by adding hydrocarbons and trace metals to the environment. As discussed in **Chapter 4.1.1.4.2.**, the volume of produced water discharged from a facility ranges from 2 to 150,000 bbl/day. One to two million bbl per year are projected to be discharged overboard from the 16 to 22 producing wells expected from a proposed action. During the years of peak activity, a maximum of 3 million bbl of produced water may be discharged. The amount of oil and grease resulting from a proposed action can be estimated from the projected annual produced water volume. Assuming a monthly oil and grease average of 29 milligrams/liter (the NPDES permit limit for oil and grease), the volume of added hydrocarbons would be 30-90 bbl/yr as the result of a proposed action.

The MMS estimates that two production structures would be installed as the result of a proposed action (**Table 4-2**). Each structure may have the capacity to receive and treat greater volumes of produced water from multiple wells than structures in shallower waters. Discharges from workovers and other activities are generally mixed with the produced water and therefore must meet the same criteria.

Several studies have been conducted to evaluate the effects of produced-water discharges from platforms on the surrounding water column, sediments, and biota (e.g., Rabalais et al., 1991; Kennicutt, 1995; CSA, 1997b). The GOOMEX study (Kennicutt, 1995) examined the effects of discharges at three natural gas platforms. Effects, including increased hydrocarbons, trace metals, and coarser grain size sediments, were observed within 150 m of the platforms. Localized hypoxia was observed during the summer months and attributed to stratification of the water column and increased organic material near the platform. The distribution of contaminants was patchy and there were several variables that could contribute to the observations, specifically sand from cuttings, hydrocarbons, and trace metals in the porewater. It was not possible to make a definitive judgement as to the precise source of observed toxic effects in the benthic community.

A bioaccumulation study (CSA, 1997b) examined trace metals and hydrocarbons in several fish and invertebrate species near platforms on the continental shelf. The produced-water discharge and ambient seawater were also analyzed for the same compounds. Of the 60 target chemicals, only two (arsenic and cadmium) were measured in the edible tissues of mollusks at levels above the USEPA risk-based concentrations. The target organic compounds were not present in most tissue samples above the target level. However, radium isotopes were measured in 55 percent of the samples, but at low concentrations.

Measurements of radium in formation water range from 40 to 1,000 pCi/l. These values are greater than marine waters, but when formation waters are discharged offshore, the radium is rapidly diluted to ambient concentrations and the higher levels are not seen as a problem (Reid, 1980).

Other Impacting Activities

Platform installation and removal result in localized sediment suspension. Also, the installation of pipelines can increase the local total suspended solids in the water. These activities result in only a temporary adverse effect on water quality.

Supply-vessel traffic affects water quality through discharges of bilge water, ballast water, and domestic and sanitary wastes. Bilge water and sanitary wastes are treated before discharge. Ballast water is uncontaminated water but may come from a source with properties, such as lower or higher salinity, different from those of the receiving waters. Estimates of the volumes of these discharges are not available.

Summary and Conclusion

During exploratory activities, the primary impacting sources to marine water quality are discharges of drilling fluids and cuttings. Any change in NPDES permit limitations would impact the volumes of fluids and cuttings discharges. Impacting discharges during production activities are produced water and supply-vessel discharges. Impacts to marine waters from a proposed action should be minimal as long as regulatory requirements are followed.

4.2.1.3. Impacts on Sensitive Coastal Environments

Impacts to the general vegetation and physical aspects of coastal environments by activities resulting from a proposed action are considered in **Chapters 4.2.1.3.1., 4.2.1.3.2., and 4.2.1.3.3.** Potential impacts to barrier islands seaward of the barrier-dune system are considered in the coastal barrier beaches and associated dunes analysis. Potential impacts to barrier islands landward of the barrier-dune system are considered in the wetlands analysis. Impacts to animals that use these environments, the recreational value of beaches, and archaeological resources found there are described in impact analysis sections for those specific resources.

The major, non-accidental, impact-producing factors associated with a proposed action that could affect these environments include navigational traffic, maintenance dredging of navigational canals, pipeline maintenance, and expansions of port facilities and processing facilities. The MMS has no direct regulatory authority over potential impact-producing factors or mitigation activities that may occur or be needed in the States' coastal zones.

4.2.1.3.1. Coastal Barrier Beaches and Associated Dunes

This section considers impacts from a proposed action to the physical shape and structure of barrier beaches and associated dunes found between Galveston Island, Texas, and the mouth of Tampa Bay, Florida. Barrier features that are found along this approximately 3,200 km of coast can be divided into two groups: sand beaches, which fringe most shores of the GOM, and the marsh coast of the Big Bend area of Florida.

The major impact-producing factors associated with a proposed action that could affect barrier beaches and dunes include pipeline emplacement, navigation channel use and maintenance dredging, and use and expansion of support infrastructure in these coastal areas.

The portions of navigation channels through the sandbars that form at the mouths of most flowing channels (bar channels) (**Chapters 3.3.5.8.2. and 4.1.2.1.8.**) generally capture and remove sediments from the longshore sediment drift, if the cross-sectional area of the channel is too large for natural tidal and storm exchanges to keep swept clear. Periodic maintenance dredging is expected in existing OCS-related navigation channels through barrier passes and associated bars. Jetties designed to reduce channel shoaling and maintenance dredging of bar channels affect the stability of barrier landforms if those jetties or the bar channel serve as sediment sinks that intercept sediment in longshore drift. Materials from maintenance dredging of bar and pass channels are typically discharged to nearby, ocean dump sites in the GOM (**Chapter 4.1.3.2.1.**, Dredged Material Disposal). This dredging usually removes sediment from the littoral sediment drift or routes it around the beach immediately downdrift of the involved channel. Placement of dredged material in shallow coastal waters forms sandbars that can impair coastal navigation.

Adverse impacts of navigation channels can be mitigated by discharging dredged materials onto barrier beaches or strategically into longshore sediment currents downdrift of maintained channels. Adverse impacts of sediment sinks created by jetties can be further mitigated by reducing the jetty length to the minimum needed and by filling the updrift side of the jetty with appropriate sediment. Sediment traps that are created by unnecessarily large bar channels may also be mitigated by reassessing the navigational needs of the port and by appropriately reducing the depth of the channel. Mitigating adverse impacts should be addressed in accordance with requirements set forth by the appropriate Federal and State permitting agencies.

A proposed action would contribute to the need to maintain the navigation channels. In the past, OCS-related facilities were built in the vicinity of barrier shorelines of the WPA, CPA, and western portion of the EPA excluding Florida. The use of some existing facilities in support of a proposed action may extend the useful lives of those facilities. During that extended life, erosion-control structures may be installed to protect a facility. Although these measures may initially protect the facility as intended, such structures may accelerate erosion elsewhere in the vicinity. They may also cause accumulation of sediments updrift of the structures, sediments that might have alleviated erosion downdrift of the structure. These induced erosion impacts would be most damaging locally. In Louisiana where the sediment supply is critically low, these impacts may be distributed much more broadly. These impacts would last as long as the interruption of the sediment drift continues, which may continue after the structure is removed if the hydrodynamics of the area are permanently modified.

Expansions of existing facilities located on barrier beaches or in associated dunes would cause loss and disturbance of additional habitat. Abandoned facility sites must be cleared in accordance with Federal, State, and local government and landowner requirements. Materials and structures that would impair or divert sediment drift among the dunes and on the beach must be removed.

Proposed Action Analysis

The use of some existing facilities in support of activities resulting from a proposed action may extend the useful life and continued presence of those facilities. During that extended life, induced erosion impacts may occur from the use of erosion-control structures. These impacts would last as long as the interruption of the sediment drift continues, which may continue after the structure is removed if the hydrodynamics of the area are permanently modified. The severity of the impact would depend upon the site and would increase with the duration of the facility-accelerated erosion. Particularly in deltaic Louisiana, recoverability from these impacts would decrease with duration. Any impacts that result from armoring these would be proportionally attributable to a proposed action.

The primary service bases projected to support a proposed action are Port Fourchon and Venice, Louisiana, and Mobile, Alabama. Secondary service bases include Cameron, Houma, Intracoastal City, and Morgan City, Louisiana; and Pascagoula, Mississippi. The average contribution of a proposed action to navigation canals associated with these service bases is expected to be small. Correspondingly, impacts resulting from maintenance dredging, wake erosion, and other secondary impacts of navigation traffic resulting from a proposed action would be inconsequential.

Sediments from maintenance dredging of bar channels and tidal inlets can benefit barrier beaches if placed strategically downstream of the channel and in the interrupted longshore sediment drift. Strategic placement would help mitigate adverse impacts caused by the presence of jetties and artificially deepened tidal passes. Strategic placement of sediments may also offset adverse impacts resulting from a proposed action. A percentage of any such benefits would be attributable to a proposed action.

Summary and Conclusion

Existing facilities originally built inland may, through natural erosion and shoreline recession, be located in the barrier beach and dune zone and contribute to erosion there. A proposed action may contribute to the continued use of such facilities. Maintenance dredging of barrier inlets and bar channels is expected to occur, which combined with channel jetties, generally causes minor and very localized impacts on adjacent barrier beaches downdrift of the channel due to sediment deprivation. The worst of these situations is found on the sediment-starved coasts of Louisiana, where sediments are largely organic. A proposed action would use navigation canals associated with the primary service bases (Port Fourchon and Venice, Louisiana, and Mobile, Alabama) and secondary service bases (include Cameron, Houma, Intracoastal City, and Morgan City, Louisiana; and Pascagoula, Mississippi). Based on use, a proposed action would account for a very small percentage of these impacts, which would occur whether a proposed action is implemented or not.

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

4.2.1.3.2. Wetlands

The area of interest in Louisiana contains about 708,570 ha of coastal wetlands. About 32,570 ha of this area are freshwater marsh and forests; 175,560 ha are intermediate salinity marsh; and 207,440 ha are brackish marsh (Louisiana Dept. of Wildlife and Fisheries, 1997). Presumably, the remaining 293,000 ha are saline marsh. These wetlands largely occur as broad expanses.

Less than 10 percent of this land is more than 3 ft above sea level, and only where five salt domes rise above the surrounding wetlands do natural elevations exceed 35 ft above mean sea level. This region contains 25 percent of the Nation's coastal wetlands and accounts for 40 percent of all salt marshes in the lower 48 states (Dunbar et al., 1992). Because more than 90 percent of the coast is less than 3 ft above sea level, an extra 1 or 2 ft of elevation loss through subsidence or erosion would have drastic effects on the available wetland habitat. Current estimates predict that nearly 640,000 acres of existing wetlands (an area nearly the size of Rhode Island) will be under water in less than 50 years (Louisiana Coastal Wetlands Conservation and Restoration Task, 1993). Mississippi contains about 64,000 ac (25,920 ha) of vegetated, coastal wetlands (Coastal Preserves Program, 1999). According to Wallace (1996), Alabama has about 75,000 ac (30,375 ha) of forested wetlands, 4,400 ac (1,782 ha) of freshwater marsh, and 35,400 ac (14,337 ha) of estuarine marsh. Finally, within the area of interest, the coastal counties of Florida contain about 2,448,725 ac (994,950 ha) of wetlands. Hardwood swamps represent the largest percentage (32.5%) of those wetlands. Hardwood swamps there are largely associated with the river deltas, such as those associated with Pensacola, Choctawatchee, and St. Andrews Bays. Estuarine wetlands, such as marsh and mangroves, represent 7.4 percent of that total (Florida Game and Freshwater Fish Commission, 1996).

The OCS oil and gas activities that could potentially impact these wetland types and their associated habitats include pipeline maintenance, maintenance dredging of navigation channels and canals, vessel usage of navigation channels, and maintenance of inshore facilities. Other potential impacts that are indirectly associated with OCS oil and gas activities are wake erosion resulting from navigational traffic, levee construction that prevents necessary sedimentary processes, saltwater intrusion that changes the hydrology leading to unfavorable conditions for wetland vegetation, and vulnerability to storm damage from eroded wetlands.

Pipelines

A proposed action is expected to contribute slightly to the overall impacts to wetlands and associated coastal habitats from OCS-related coastal required pipeline maintenance. As previously discussed in **Chapter 4.1.1.8.1.**, Pipelines, petroleum reservoirs in deepwater areas might require their own pipeline landfall. No new pipelines in coastal waters or pipeline landfalls are projected as a result of a proposed action.

As of August 2001, there were more than 45,000 km of pipelines in Federal offshore lands and approximately 16,000 km of OCS pipelines extend into State waters and onshore. Many OCS pipelines make landfall on Louisiana's barrier island and wetland shorelines (Falgout, 1997). Louisiana wetlands protect pipelines from waves and ensure that the lines stay buried and in place.

Secondary impacts of pipeline channels can be even more damaging to coastal wetlands and associated habitats than the primary impacts (Tabberer et al., 1985). Secondary impacts include expansion of tidal influence, saltwater intrusion, hydrodynamic alteration, erosion, sediment export, flank subsidence, and habitat conversion. During reviews of pipeline projects for Federal and State permits, agencies consistently comment with concern upon the extent of these secondary impacts. As a result, structures engineered to mitigate secondary adverse impacts are included as permit requirements. The number of OCS-related mitigative structures around the Gulf Coast is unknown.

Frequently, the non-maintenance of structures used to mitigate adverse impacts of pipeline construction allows the structures to deteriorate and eventually fail. Consequently, the indirect and adverse impacts upon wetlands that the structures were designed to prevent or mitigate could resume and possibly proceed at an accelerated rate. No known effort has been made to document the frequency or extent of these failures or the severity of the resulting impacts. Quantifying indirect impacts have proven to be difficult and highly debatable. The widening of pipeline canals over time is one of the more obvious secondary impacts; however, extricating secondary impacts of canals from all other losses remains a challenge. A number of studies have examined the correlative evidence linking wetland loss to canal densities (Turner et al. 1982; Saife et al., 1983; Turner and Cahoon, 1988; Turner, 1987; Bass and Turner, 1997). In general, it appears that for most of the Louisiana coast a positive relationship exists between canal density and wetland loss. The limitation of this suggestion is that it fails to identify any cause and effect relationship; however, it may provide a basis upon which to support a hypothesis about the secondary impacts of canals on wetland loss rates.

Craig et al. (1980) studied a series of canals in Louisiana and determined that the canals widened at rates of 2-14 percent per year. Dead-end canals with little vessel traffic or significant flow were shown to widen at rates within this range. Based on the 1980 study and due to their shallow nature, OCS-related pipeline canals were expected to widen at an average rate of approximately 4 percent per year. One current line of research in coastal Louisiana involves either (1) an estimate of the percent of total wetland loss or (2) determining a ratio of the relative contribution of direct to indirect wetland losses. Turner and Cahoon (1988) suggest that 20-60 percent of wetland loss is from secondary oil impacts, with 4-13 percent attributed to OCS activities. More recently, Penland (1999), in a detailed GIS analysis of causes of wetland loss in the Louisiana Deltaic Plain, concluded that approximately 20 percent of wetland loss could be attributed to secondary impacts of OCS activities. Day et al. (in press) suggest that in some basins in Louisiana as much as 32 percent of wetland loss may be indirectly caused by canals (i.e., Barataria, Mermenteau basins); however, Day et al. also found that no or minimal wetland loss may be attributable to secondary canal impacts in other basins such as the Atchafalaya.

The length and width of OCS-related pipeline canals around the Gulf Coast are unknown. The results of an MMS/USGS-BRD study investigating coastal wetland impacts from the widening of OCS-related pipeline canals and the effectiveness of mitigation reveal the following preliminary data: (1) Total length of OCS pipelines from offshore – 3 mi (State/Federal boundary) to the inland coastal zone boundary was approximately 16,000 km. Sources of data were PennWell Mapsearch, National Pipeline Mapping System, and Louisiana Geological Survey pipeline data. (2) Total increase in water versus land within a 300-m buffer for each OCS pipeline from 1956 to 1990 was 37,709 ha. This number represented 9.7 percent of the total increase in water versus land for coastal Louisiana from 1956 to 1990. It should be mentioned that a great number of these pipelines were installed prior to implementation of NEPA (1969) and, more recently, the State of Louisiana's Coastal Permit Program in 1981. Additionally, given the width of buffer (300 m) versus actual pipeline width, which may be a 100 to 200 ft wide, a portion of water increase may be attributed to other factors unrelated to OCS activities. To address this issue, selected OCS pipelines are being studied in greater detail to ascertain direct and secondary impacts to the extent possible. The information from the analysis will be forthcoming. At present, there is no known study addressing the effectiveness or longevity of canal-related mitigation. Recently, MMS identified and mapped existing onshore OCS-related pipelines in the GOM coastal regions, including the Chenier Plain. With the OCS pipelines identified, the MMS/USGS-BRD study provides basic information for the EIS's developed by MMS and for mitigative measures implemented by other Federal and State permitting agencies.

Dredging

No new navigational channels are expected to be dredged/constructed as a result of a proposed action. Deepwater activities, such as those anticipated with a proposed action, require the use of larger service vessels for efficient operations. This may put substantial emphasis on shore bases associated with deeper channels. Some of the ports that have navigation channels deep enough to accommodate deeper-draft vessels may expand port infrastructure to accommodate these deeper-draft vessels. An example of a significant expansion of a service base is Port Fourchon in coastal Louisiana. Port Fourchon has deepened the existing channel and has dredged additional new channels to facilitate this expansion. Dredging and dredged-material disposal can be detrimental to coastal wetlands and associated fish and wildlife that use these areas for nursery grounds, protection, etc. Periodic maintenance dredging of navigation channels deposits material on existing dredged-material disposal banks and disposal areas; the effects of dredged-material disposal banks on wetland drainage is expected to continue unchanged, although there may be some localized and minor exacerbation of existing problems. Typically, some dredged material intended for placement on a dredged-material disposal bank is placed in adjacent wetlands or shallow water. Wetland loss due to dredge material deposition is expected to be offset by wetland creation as adjacent margins of shallow water are filled. In both cases, areas impacted are considered small. Maintenance dredging would also temporarily increase turbidity levels in the vicinities of the dredging and disposal of materials, which can impact emergent wetlands, seagrass communities, and associated habitats. Two different methods are generally used to dredge and transport sediments from channels to open-water sites: (1) hydraulic cutterhead suction dredge with transfer of the sediments via connecting pipelines; and (2) clamshell bucket dredge with transfer of the sediments via towed bottom-release scows. Each method produces a distinctly different deposit. Hydraulic dredging creates a slurry of sediment and water, which is pumped through a pipeline to a basin-like depression in proximity to the channel. The majority of the sediment settles to the bottom where it spreads outward under the force of gravity and tends to fill the basin. The clamshell dredge scoops sediments relatively intact into scows, which are then towed to the designated area, and then releases the sediment onto the specified area for disposal. This method usually produces positive relief features in the placement area.

Access canals, as well as pipeline canals, are commonly surrounded by levees created using dredged materials (Rozas, 1992). Placement of this material alongside canals converts marsh to upland, an environment unavailable to aquatic organisms except during extreme tides. Dredge material can also form a barrier causing ponding behind levees and limiting exchanges between canal waters and marshes to infrequent, high-water events (Swenson and Turner 1987; Cox et al., 1997). This and similar disruptions to marsh hydrology are believed to change coastal habitat structure as well as accelerate marsh erosion and conversion to open water (Kuhn et al., 1999; Turner et al., 1994; Rozas, 1992; Turner and Cahoon, 1987). The MMS/USGS-BRD study previously mentioned above (pipelines) will attempt to quantify the impacts of dredge material deposition as well as other canal-related impacts, which should provide insights for identifying past and future impacts.

Executive Order 11990 requires that material from maintenance dredging be considered for use as a sediment supplement in deteriorating wetland areas to enhance and increase wetland acreage, where appropriate. Disposal of dredged material for marsh enhancement has been done only on a limited basis (**Chapter 4.1.3.2.1.**, Dredged Material Disposal). Given the "mission statement" of the COE, which requires it to take environmental impacts into consideration during its decisionmaking processes, increased emphasis has been placed on the use of dredged material for marsh creation. For a proposed action, increased use of dredged material to enhance wetland habitats is encouraged as mitigation.

Vessel Traffic and Saltwater Intrusion

Vessel traffic that may support a proposed action is discussed in **Chapter 4.1.1.8.2.**, Service Vessels. Navigation channels projected to be used in support of a proposed action are discussed in **Chapter 4.1.2.1.8.**, Navigation Channels. Navigation channels that support the OCS Program are listed in **Table 3-33**. Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in areas already affected by natural erosion process. An increase in the number of vessels creating wakes could potentially impact coastal habitat including wetlands.

According to Johnson and Gosselink (1982), canals that have high navigation usage in coastal Louisiana widen about 2.58 m/yr, compared with 0.95 m/yr for little used canals. The OCS-related navigation canals are assumed to generally widen at an average rate of 1.5 m/yr. Approximately 3,200 km of OCS-related navigation canals, bayous, and rivers are found in the coastal regions around the GOM, exclusive of channels through large bays, sounds, and lagoons. About 2,000 km is found in the CPA.

Specific to navigation channels is the effects from saltwater intrusion (Gosselink et al., 1979; Wang, 1987). Wang developed a model demonstrating that, under certain environmental conditions, saltwater penetrates farther inland in deep navigation type channels than in shallower channels, suggesting that navigation channels act as "salt pumps." The Calcasieu Ship Channel is a good example of how saltwater intrustion, as a consequence of channelization, results in significant habitat transition from freshwater to brackish and ultimately to salt or open water systems. Another example is the construction of the Mississippi River Gulf Outlet (MRGO) that has lead to the transition of many of the taxodium swamps east of the Mississippi River below New Orleans to open water, which are largely composed of Spartina with old Taxodium trunks.

There are two major waterways that support vessel traffic associated with OCS activities: (1) the GIWW completed in 1949, and as previously mentioned, (2) the MRGO opened through the wetlands of St. Bernard Parish in 1963. The GIWW carries barges of crude oil, petroleum, bulk cargoes, and miscellaneous items along a 12-ft deep channel protected from the storms, waves, and winds of the GOM. Maintenance dredging of the MRGO has always been necessary, especially in areas such as Breton Sound where the channel crosses open water. Continued use of this navigation channel, annual dredging, and the instability of the banks has caused the main channel of the MRGO to widen from 500 to 2,000 ft in some places.

Much of the service-vessel traffic that is a necessary component of OCS activities uses the channels and canals along the Louisiana coast. An increase in the number of vessels creating wakes could potentially increase impacts to coastal habitats including wetlands.

Disposal of OCS-Related Wastes

Produced sands, oil-based drilling muds and cuttings, and some fluids from well treatment, workover, and completion activities would be transported to shore for disposal. Sufficient disposal capacity exists at the disposal site near Lacassine, Louisiana (coastal Subarea LA-1) and at other disposal sites in Subareas TX-2, LA-1, LA-2, and MA-1 (**Chapter 4.1.2.1.6.**, Disposal and Storage Facilities for Offshore Operational Wastes). Discharging OCS-related produced water into inshore waters has been discontinued. All OCS-produced waters are discharged into offshore waters in accordance with NPDES permits or transported to shore for injection. Produced waters are not expected to affect coastal wetlands (**Chapter 4.1.1.4.**, Operational Waste Discharged Ofshore).

Because of wetland protection regulations, no new waste disposal site would be developed in wetlands. Some seepage from waste sites into adjacent wetland areas may occur and result in damage to wetland vegetation. State requirements are expected to be enforced to prevent and correct such occurrences.

Onshore Facilities

Various kinds of onshore facilities service OCS development. These facilities are described in **Chapter 4.1.2.1.**, Coastal Infrastructure, and **Table 4-7**. State and Federal permitting agencies discourage the placement of new facilities and the expansion of existing facilities in wetlands. Any impacts upon wetlands are usually mitigated. All projected new facilities are attributed to the OCS Program, with an appropriate proportion attributed to a proposed action.

Proposed Action Analysis

Direct causes of Louisiana wetland loss may be attributed to the following activities associated with a proposed action:

- dredging and stream channelization for navigation channels and pipeline canals;
- filling for dredged material and other solid-waste disposal;
- roads and highways; and
- industrial expansion.

Indirect causes of wetland loss may be attributed to:

- sediment diversion by deep channels;
- hydrologic alterations by canals, dredged-material disposal banks, roads, and other structures; and
- subsidence due to extraction of groundwater.

Oil production from a proposed action is expected to be commingled in pipelines with other OCS production before going ashore. No new pipelines in coastal waters or pipeline landfalls are projected as a result of a proposed action.

A proposed action is projected to contribute a small amount to the usage of OCS-related navigation channels; therefore, impact related to a proposed action should remain minimal. Since the number of OCS-related mitigative structures is unknown, impacts creditable to a proposed action cannot be calculated. Impacts associated with canals and mitigation structures include altered hydrology and flank subsidence, for which methods of projecting rates of occurrence and extent of influence have not yet been developed. An MMS study of canal-impact issues is expected in the spring of 2002.

Summary and Conclusion

A proposed action is projected to result in the construction of no new pipeline landfalls and would use the existing pipeline system. Secondary impacts, such as continued widening of existing pipeline and navigation channels and canals, as well as the failure of mitigation structures, are also expected to convert wetlands to open water.

Maintenance dredging of navigation channels and canals is expected to occur with minimal impacts; a proposed action is expected to contribute minimally to the need for this dredging. Alternative dredged-material disposal methods can be used to enhance and create coastal wetlands. By artificially keeping navigation channels open and with larger dimensions than the region's natural hydrodynamic processes, maintenance dredging maintains tidal and storm flushing potential of inland regions at maximum capacities as they relate to the described needs of the canal project. Without maintenance dredging, these channels would naturally fill in, reducing the channels' cross-sectional areas and their capacities to flush or drain a region when under the influences of storms and tides.

In conclusion, adverse initial impacts and more importantly secondary impacts of maintenance, continued existence, and the failure of mitigation structures for pipeline and navigation canals are considered the most significant OCS-related and proposed-action-related impacts to wetlands. Although initial impacts are considered locally significant and largely limited to where OCS-related canals and channels pass through wetlands, secondary impacts may have substantial, progressive, and cumulative adverse impacts to the hydrologic basin or subbasin in which they are found. The broad and diffuse distribution of OCS-related activities offshore and along the Central Gulf Coast makes it difficult to distinguish proposed action impacts from other ongoing OCS and non-OCS impacts to wetlands. The MMS has initiated studies to better evaluate these impacts and related mitigative efforts.

4.2.1.3.3. Seagrass Communities

Seagrasses are restricted to small shallow areas behind barrier islands in Mississippi and Chandeleur Sounds and to smaller, more scattered populations elsewhere. Lower-salinity, submerged seagrass beds are found inland and discontinuously throughout the coastal zone. Most seagrass communities and associated habitat are located between the Southwest Pass of the Mississippi River and Cape San Blas, Florida and are inland of the barrier shorelines. Most seagrass habitat in this region usually remains submerged because of the micro-tidal regime of the northern GOM. Only during extremely low, wind-driven tidal events would seagrass beds be exposed to the air. Even then, their roots and rhizomes remain buried in the water bottom. Activities that may result from a proposed action that could adversely affect submerged vegetation beds include maintenance dredging of navigational channels, vessel traffic, oil spills, and spill response and cleanup. The potential impacts of oil spills on seagrass communities and spill-response and cleanup activities are discussed in **Chapter 4.4.3.3.**

Maintenance Dredging

No new navigational channels are expected to be dredged as a result of a proposed action. Maintenance dredging schedules vary from yearly to rarely and would continue indefinitely into the future. Deepwater activities are anticipated to increase, which would likely require greater use of larger service vessels for efficient operations and may cause greater use of shore bases associated with deeper channels.

Some of the ports that have navigation channels deep enough to accommodate deeper-draft vessels may expand the port infrastructure to accommodate these deeper-draft vessels. A small portion of this need would be attributable to a proposed action. An example of a significant expansion of a service base is Port Fourchon in coastal Louisiana. Port Fourchon has deepened existing channels and has dredged additional new channels to facilitate this expansion. Light attenuation is responsible for most landscape-level losses. The amount of light reaching the bottom of a seagrass bed is the crucial factor determining seagrass meadow extent and productivity. Reduced light has been linked to reductions of both seagrass cover and productivity (Orth and Moore 1983; Kenworthy and Haunert 1991; Dunton 1994; Czerny and Dunton 1995). It has been determined that one of the major causes of light reduction that results in changes in seagrass cover, composition, and biomass is dredging. Changes in species composition are usually the result of natural processes (i.e., succession), but they can be caused by salinity moderation resulting from dredging. Changes in species composition resulting from dredging activities may affect resource availability for some fish and waterfowl that use seagrass habitat as nursery grounds. Turbidity caused by maintenance dredging has been implicated in the decline of shoalgrass and increased bare areas in the lower Laguna Madre (Onuf, 1994) located behind the south Texas barrier islands.

Maintenance dredging keeps navigation channels open and artificially maintains larger channel dimensions than would occur naturally under regional hydrodynamics. Dredging also increases the potential for tidal and storm flushing of inland regions. Without maintenance dredging, these channels would naturally fill in, reducing the channels' cross-sectional areas and their capacities to flush or drain a region when under the influence of storms and tides.

Vessel Traffic

Navigation traffic that may support a proposed action is discussed in **Chapter 4.1.1.8.2.**, Service Vessels. Navigation channels projected to be used for a proposed action are used by vessels that support the OCS Program (**Table 3-33**). The GIWW is dredged to 4 m, but it is actually about 5.5 m deep between the Pascagoula Channel and the Bayou LaBatre Channel and generally about 3.7 m deep between the Bayou LaBatre and Mobile Bay Channels. Prop wash of shallow navigation channels by vessel traffic dredges up and resuspends sediments, increasing the turbidity of nearby coastal waters.

Proposed Action Analysis

Maintenance Dredging

Because much of the dredged material resulting from maintenance dredging would be placed on existing dredged-material disposal sites or used for other mitigative projects, no significant adverse impacts are expected to occur to seagrass communities from maintenance dredging related to a proposed action.

Vessel Traffic

Navigational traffic through the GIWW between the Bayou LaBatre Channel and Mobile Bay Channel would resuspend sediments. A proposed action would contribute to a percentage of traffic through that stretch. However, seagrass habitat within the area of influence of that channel and other channels has already adjusted their configurations in response to turbidity generated there.

Vessels that vary their inland route from established navigation channels can directly scar beds of submerged vegetation with their props, keels (or flat bottoms), and anchors. Many vessel captains may cut corners of channel intersections or navigate across open water where they would unexpectedly encounter shallow water where beds of submerged aquatic vegetation may occur. Propellers may damage a bed superficially by leaving a few narrow cuts. Damage may be as extensive as broadly plowed scars from the keel of a large boat accompanied by extensive prop washing; trampling by waders; and additional keel, prop, and propwash scars left by other vessels that assisted in freeing the first boat.

Depending upon the submerged plant species involved, scars about 0.25-m wide cut through the middle of beds would take 1-7 years to recover. Similar scars through sparser areas would take 10 years or more to recover. The broader the scar, the longer the recovery period. Extensive damage to a broad area may never be corrected (Sargent et al., 1995; Durako et al., 1992).

Denser dredged materials fall out of suspension more quickly. Less dense sediments settle to the water bottom more slowly, which concentrates at the surface of the water bottom. These lighter bottom sediments are generally more easily resuspend by storms than were the original surface sediments. Hence, for a period of time after dredging occurs, water turbidity would be greater than usual in the vicinity of the dredging. With time, this reoccurring, increased turbidity would decrease to pre-project conditions, as the lighter materials are either dispersed to deeper water by currents, where they are less available for resuspension, or they are consolidated into or under denser sediments.

For estuarine species that thrive in salinities of about 0.5-25 ppt, this elevated turbidity may not pose a significant problem, since they have adapted to turbid, estuarine conditions. For seagrasses in higher salinities and even freshwater submerged aquatic vegetation that requires clearer waters, significantly reduced water clarity or shading, as may be caused by an oil slick, for longer than about 4 days would decrease chlorophyll production. If such conditions continue for longer than about 2 weeks, plant density in the bed would begin to decrease. If plant density reduces significantly, further increases in turbidity would occur as the root, thatch, and leaf coverage decline. Such impacts can be mitigated in several ways. Activities over grass beds should be closely monitored to avoid digging into the bed. Trampling or repeatedly walking over a path through the bed should be avoided.

Summary and Conclusion

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

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

Because much of the dredged material resulting from maintenance dredging would be placed on existing dredged-material disposal sites or used for other mitigative projects, no significant adverse impacts are expected to occur to seagrass communities from maintenance dredging related to a proposed action.

4.2.1.4. Impacts on Sensitive Offshore Benthic Resources

4.2.1.4.1. Continental Shelf

4.2.1.4.1.1. Live Bottoms (Pinnacle Trend)

Seventy blocks are within the region defined as the pinnacle trend, which contains live bottoms that may be sensitive to oil and gas activities. These blocks are located in the northeastern portion of the CPA and are located between 53- and 110-m water depths in the Main Pass and Viosca Knoll lease areas. There are also four blocks containing pinnacles in adjacent areas of the EPA. Potential pipelines from the proposed lease sale area could traverse leases in the pinnacle trend in the CPA; however, the Live Bottom (Pinnacle Trend) Stipulation placed on these CPA leases is designed to prevent drilling activities and anchor emplacement (the major potential impacting factors on these live bottoms resulting from offshore oil and gas activities) from damaging the pinnacles. Accidental impacts may be caused by operator positioning errors or when studies and/or geohazards information are inaccurate in mapping or fail to note the presence of pinnacle features.

A number of OCS-related factors may cause adverse impacts on the pinnacle trend communities and features. Damage caused by pipeline emplacement, blowouts, and oil spills can cause the immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible. Impacts from oil spills and blowouts on live bottoms are discussed in **Chapter 4.4.4.1.1.**

Proposed Action Analysis

The pinnacles are not located within the proposed lease sale area; however, pipelines that would support a proposed action may go through the pinnacle trend. Pipeline emplacement has the potential to cause considerable disruption to the bottom sediments in the vicinity of the pinnacles (**Chapter 4.1.1.8.1.**, Pipelines); however, the Live Bottom Stipulation, or a similar protective measure, would restrict pipeline-laying activities in the vicinity of the pinnacle communities. Data gathered for the Mississippi-Alabama Continental Shelf Ecosystem Study (Brooks, 1991) and the Mississippi/Alabama Pinnacle Trend Ecosystem Monitoring, Final Synthesis Report (Continental Shelf Associates, Inc. and Texas A&M University, Geochemical and Environmental Research Group, 2001) document dense biological communities (i.e., live-bottom communities, fish habitat, etc.) on the high- and medium-relief pinnacle features themselves and live-bottom organisms more sparsely distributed in unconsolidated bottom sediments surrounding the pinnacles. The actual effect of pipeline-laying activities on the biota of the pinnacle communities would be restricted to the resuspension of sediments. The Live Bottom Stipulation would help to minimize the impacts of pipeline-laying activities throughout the pinnacle region. Two pipelines are projected to result under a proposed action. The severity of these actions has been judged at the community level to be slight, and impacts from these activities to be such that there would be no measurable interference to the general ecosystem.

Summary and Conclusion

Activities resulting from a proposed action are not expected to adversely impact the pinnacle trend environment because of the Live Bottom Stipulation. No community-wide impacts are expected. The Live Bottom Stipulation would minimize the potential for mechanical damage. Potential impacts would be from pipeline emplacement only and would be minimized because of the proposed Live Bottom Stipulation. The frequency of impacts on the pinnacles would be rare, and the severity should be slight because of the widespread nature of the features.

4.2.1.4.2. Continental Slope and Deepwater Resources

4.2.1.4.2.1. Chemosynthetic Communities

Physical

The greatest potential for adverse impacts on deepwater chemosynthetic communities would come from those OCS-related, bottom-disturbing activities associated with pipelaying (**Chapter 4.1.1.8.1.**), anchoring (**Chapter 4.1.1.3.4.1.**), and structure emplacement (**Chapter 4.1.1.3.3.2.**, Bottom Area Disturbance), as well as from an accidental seafloor blowout (**Chapter 4.3.2.**). Potential impacts from blowouts on chemosynthetic communities are discussed in **Chapter 4.4.4.2.1.** These activities cause localized bottom disturbances and disruption of benthic communities in the immediate area.

Considerable mechanical damage could be inflicted upon the bottom by routine OCS drilling activities. The physical disturbance by structures related to a drilling operation itself affects a small area of the sea bottom. The presence of a conventional structure can also cause scouring of the surficial sediments by near-bottom ocean currents (Caillouet et al., 1981), although this phenomenon has not been demonstrated around structures in deep water. However, there is a great deal of evidence that strong currents do occur in deep water (Hamilton and Lugo-Fernandez, 2001).

Anchors from support boats and ships (or, as assumed for deeper water depths, from any buoys set out to moor these vessels), floating drilling units, barges used for construction of platform structures, and pipelaying vessels also cause severe disturbances to small areas of the seafloor. The areal extent and severity of the impact are related to the size of the mooring anchor and the length of chain resting on the bottom. Excessive scope and the movement of the mooring chain could disturb a much larger bottom area than an anchor alone, depending on the variety of prevailing wind and current directions. A 50-m radius of chain movement on the bottom around a mooring anchor could destroy chemosynthetic communities in an area of nearly 8,000 m^2. A large area of bottom could also be disturbed by bottom contacts of the entire length of chain or cable for each anchor prior to and during the anchor cable tensioning from the central drilling structure. Larger anchors, longer anchor chains/cables and mooring lines, and greater scope for anchoring configurations are expected for operations in deep water as compared to operations on the shelf. Therefore, the areal extent of impacts, both for individual anchors and for the entire footprint, is expected to be greater for operations that employ anchoring in deep water. Many oil and gas support operations involving ships and boats would not result in anchor impacts on deepwater chemosynthetic communities because the vessels would tie-up directly to rigs, platforms, or mooring buoys. In addition, there are drillships, construction barges, and pipelaying vessels operating in the GOM that rely on dynamic positioning rather than conventional anchors to maintain their position during operations (anchoring would not be a consideration in these situations). The area affected by anchoring operations would depend on the water depth, length of the chain, size of the anchor, and current. Anchoring would destroy those sessile organisms actually hit by the anchor or anchor chain during anchoring and anchor weighing, or it could cause destruction of underlying carbonate structures on which chemosynthetic organisms rely for dispersion of hydrocarbon sources. While such an area of disturbance may be small in absolute terms, it may be large in relation to the area inhabited by dense chemosynthetic communities.

Normal pipelaying activities in deepwater areas could destroy large areas of chemosynthetic organisms (it is assumed that 0.32 ha of bottom is disturbed per kilometer of pipeline installed). Since pipeline systems are not as established in deepwater as in shallow water, new installations are required, which would tie into existing systems. Pipelines would also be required to transport product from subsea systems to platforms.

In addition to physical impacts, structure removals and other bottom-disturbing activities could resuspend bottom sediments. The potential effects of resuspended bottom sediments are similar to those from the discharge of muds and cutting discussed below.

The impacts from bottom-disturbing activities are expected to be relatively rare. Should they occur, these impacts could be quite severe to the immediate area affected, with recovery times as long as 200 years for mature tube-worm communities, with the possibility of the community never recovering.

Discharges

In deep water, discharges of drilling fluids and cuttings at the surface are spread across broader areas of the seafloor and are, in general, distributed in thinner accumulations than in shallower areas on the continental shelf. Gallaway and Beaubien (1997) have reported recent information about the effects of surface discharge of drilling fluids (muds) and cuttings at a well in 565 m. In this instance, a veneer of cuttings was observed scattered over the bottom, in some cases as thick as 20-25 cm. Chemical evidence of SBF components (used during this operation) was found at distances of at least 100 m from the well site (sampling distance was limited by the ROV tether length). Other information from a geophysical survey documented the extent of drilling discharges at several previously drilled oil and gas sites in about 400 m water depths (Nunez, personal communication, 1994). At these sites, the areal coverage of cuttings was found extending from the previous well locations in splay or finger-like projections to a maximum of about 610 m, with an average of about 450 m. An examination of side-scan-sonar records of these splays indicates that they were distributed in accumulations less than 30 cm thick. Effluents from routine OCS operations (not muds or cuttings) in deep water would be subject to rapid dilution and dispersion and are not projected to reach the seafloor at depths greater than 100 m.

Impacts from muds and cuttings are also expected from two additional sources: (1) initial well drilling and installation of casing prior to the use of a riser to circulate returns to the surface; and (2) the potential use of various dual-gradient or subsea mudlift drilling techniques in the deep sea. Pre-riser casing installation typically involves 36-in (91-cm) casing that may be set to a depth of 300 ft (91 m) and 26-in (66-cm) casing that may be set to a depth of 1,600 ft (488 m). Jetted or drilled cuttings from the initial wellbore could total as much as 226 m^3 (Halliburton Company, 1995). With dual-gradient drilling techniques, the upper portion of the wellbore would be “drilled” similar to conventional well initiation techniques with cuttings being discharged at the seafloor. After the BOP stack is installed, subsea mudlift pumps would circulate the drilling fluid and cuttings to the surface for conventional well solids control. Discharges from the dual-gradient drilling operations are expected to be similar to conventional drilling operations. Although the full areal extent and depth of burial from these initial activities are not known, the potential impacts are expected to be localized and short term. Since these areas would occupy a minuscule portion of the available seafloor in the deepwater GOM, these impacts are not considered significant provided that sensitive communities (e.g., chemosynthetic communities) are avoided.

MacDonald et al. (1995) indicates that the vulnerability of chemosynthetic communities to oil and gas impacts may depend on the type of community present. Tube-worm and mussel communities may be more vulnerable than clam communities because clam communities are vertically mobile (preventing burial) and sparsely distributed. The primary concern related to muds and cuttings discharges is that of burial. Although chemosynthetic organisms thrive with some part of their anatomy located next to or inside of toxic and/or anoxic environments, all chemosynthetic biota (including the symbiotic bacteria) also require oxygen to live. Burial by sediments or rock fragments originating from drilling fluids and cuttings discharges would smother and kill most chemosynthetic organisms (motile clams being one possible exception). Depending on the organism type, just a few centimeters of burial could cause mortality.

The tolerance of various community components to burial is not completely understood and would depend on the depth of burial. Detrimental effects due to burial are expected to decrease exponentially in the same manner that the depth of accumulations of discharges decreases exponentially with distance from the origin. The severity of these impacts is such that there may be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

High-density, Bush Hill-type communities are areas that are considered to be most at risk from oil and gas operations. The disturbance of a Bush Hill-type environment could lead to the destruction of a community from which recovery would occur only over long time intervals (200+ years for a mature tube-worm colony and 25-50 years for a mature mussel community) or would not occur at all. A long span of time is required for the precipitation of enough carbonate rock to support a large population of tube worms. As dense tube-worm communities require hard substrate as well as very active seepage at any point in space, existing communities covered by sediment that are physically damaged would likely never recover (Fisher, 1995).

Information is limited about the vulnerability of tube worms to sedimentation/smothering impact. Individual tube worms are often found buried for more than half the length of their tubes by hemipelagic sediment (MacDonald, 1992). Presumably, this burial occurs over long time intervals. Evidence of catastrophic burial of high-diversity chemosynthetic communities can be found in the paleorecord as documented by Powell (1995), but the importance of this in causing local extinctions was reported as minor. These burials were probably caused by catastrophic seismic events.

Methanotrophic mussel communities have strict chemical requirements that tie them directly to areas of the most active seepage. Physical disturbance of an active mussel bed is thought not to have a long-lasting effect on the community due to high growth rates of individuals (Fisher, 1995). Catastrophic mud burial would be one possible cause of a mussel community death. It is predicted that a mussel community completely eliminated by physical disturbance could be resettled and mature within 20 years.

Reservoir Depletion

There has been some speculation about the potential impact to chemosynthetic communities as a result of oil and gas withdrawal, causing a depletion of the energy source (hydrocarbons) sustaining the chemosynthetic organisms. There is evidence that both removal and reinjection of material into reservoirs that supply seeps on land in California affect the seepage rates. Quigley et al. (1996) reported evidence that suggested offshore California oil production resulted in reduced seepage due to reduction in reservoir pressure. The seeps and faults around which chemosynthetic animals live are supplied from the deep reservoirs that transport the gas or oil to the seafloor through combined effects of buoyancy and pressure. In the proposed lease sale area, when all of the recoverable hydrocarbons from these reservoirs are withdrawn by production operations (the amount that can be economically extracted by current technology is estimated to be 29-65% of the total hydrocarbons), it is possible that oil and gas venting or seepage would also slow or (less likely) stop. Based on current information, it is not possible to determine whether reduced reservoir pressure would actually reduce the seepage (as observed onshore) or whether there may be enough oil already in the conduit to the surface to continue adequate levels of seepage for long periods, perhaps thousands of years or more. The distribution of chemosynthetic communities is known to occur in association with precise levels and types of chemical gradients at the seafloor; alterations to these gradients may potentially impact the type and distribution of the associated community.

Proposed Action Analysis

Because high-density chemosynthetic communities are generally found only in water depths greater than 400 m, they could be found throughout the proposed lease sale area (1,600-3,000m) and the two projected pipeline routes (>500m). Of the 45 known communities, none are known to exist in a proposed action area. The closest known community is located in Viosca Knoll Block 926, approximately 23 nmi to the north-northeast of the proposed lease sale area. The levels of projected impact-producing factors for a proposed action are shown in **Table 4-2**. A total of only two oil and gas production structures are estimated to be installed as a result of a proposed action. These deepwater production structures are expected to be installed 3-4 years after a proposed lease sale.

The NTL 98-11 (superseded by NTL 2000-G20) has been a measure for the protection of chemosynthetic communities since February 1, 1989. Now, NTL 2000-G20 makes mandatory the search for and avoidance of dense chemosynthetic communities (such as Bush Hill-type communities) or areas that have a high potential for supporting these community types, as interpreted from geophysical records. The NTL is exercised on all applicable leases and is not an optional protective measure. Under the provisions of this NTL, lessees operating in water depths greater than 400 m (the entire area of a proposed action) are required to conduct geophysical surveys of the area of proposed activities and to evaluate the data for indications of conditions that may support chemosynthetic communities. If such conditions are indicated, the lessee must either move the operation to avoid the potential communities or provide photodocumentation of the presence or absence of dense chemosynthetic communities of the Bush Hill type. If such communities are indeed present, no drilling operations or other bottom-disturbing activities may take place in the area; if the communities are not present, drilling, anchoring, etc. may proceed. To date, in almost all cases, operators have chosen to avoid any areas that show the potential to support chemosynthetic communities. The basic assumptions underlying the provisions of this mitigation measure are (1) that dense chemosynthetic communities are associated with gas-charged sediments or seeps, (2) that the gas-charged sediment zones or seeps have physical characteristics that would allow them to be identified by geophysical surveys, and (3) that dense chemosynthetic communities are not found in areas where gas-charged sediments or seeps are not indicted on the geophysical survey data. These assumptions have not been totally verified. A definitive correlation between the geophysical characteristics recorded by geophysical surveys and the presence of chemosynthetic communities has not been proven.

Although there are few examples of field verification, the requirements set forth in NTL 2000-G20 are considered effective in identifying potential areas of chemosynthetic communities. Although there has generally been compliance with NTL 2000-G20, compliance does not guarantee avoidance of high-density communities without visual confirmation in every case. On rare occasions, high-density chemosynthetic community areas may not be properly identified using the geophysical systems and indicators specified in the existing NTL. Oil- or gas-saturated sediments and other related characteristic signatures cannot be determined without high-resolution acoustic records or the interpretation of subsurface 3D seismic data.

Improved definitions and avoidance distances are part of the new Chemosynthetic Community NTL 2000-G20. Requirements for specific separation distance between potential high-density chemosynthetic communities and both anchors (250-500 ft) and drilling discharge points (1,500 ft) have been included in the revision of the NTL. These guidelines have also been released in NTL 2002-G08, which became effective August 29, 2002. The potential for any impact could also be lessened by the refinement of techniques used in the interpretations of geophysical records. The use of differential global positioning system (GPS) has also been required on anchor handling vessels when placing anchors near an area that has potential for supporting chemosynthetic communities. As new information becomes available, the NTL would be further modified as necessary.

High-density, Bush Hill-type communities are, as noted above, largely protected from direct physical impacts by the provisions of NTL 2000-G20. A limited number of these communities have been found to date, but it is probable that additional communities exist. Observations of the surface expression of seeps from space images indicate numerous other communities may exist (MacDonald et al., 1993 and 1996). Most chemosynthetic communities are of low density and are relatively widespread throughout the deepwater areas of the GOM. Physical disturbance or destruction of a small, low-density area would not result in a major impact to chemosynthetic communities as an ecosystem. Low-density communities may occasionally sustain major or minor impacts from discharges of drill muds and cuttings, bottom-disturbing activities, or resuspended sediments. Areas so impacted could be repopulated from nearby undisturbed areas (although this process may be quite slow, especially for vestimentiferans). In light of probable avoidance of all chemosynthetic communities (not just high-diversity types), as required by NTL 2000-G20, the frequency of such impact is expected to be low, and the severity of such an impact is judged to result in minor disturbance to ecological function of the community, with no alteration of ecological relationships with the surrounding benthos. Recolonization after a disturbance would not exactly reproduce the preexisting community prior to the impact, but it could be expected that some similar pattern and species composition would eventually reestablish if similar conditions of sulfide or methane seepage persist after the disturbance.

Summary and Conclusion

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

If the presence of a high-density community were missed using existing procedures, potentially severe or catastrophic impacts could occur due to partial or complete burial by muds and cuttings associated with pre-riser discharges or some types of riserless drilling. To date, there are no known impacts from oil and gas activities on a high-density chemosynthetic community. Variations in the dispersal and toxicity of synthetic-based drilling fluids may contribute to the potential areal extent of these impacts. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

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

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

4.2.1.4.2.2. Nonchemosynthetic Communities

Physical

Benthic communities other than chemosynthetic organisms could be impacted by OCS-related, bottom-disturbing activities associated with pipelaying (**Chapter 4.1.1.8.1.**), anchoring (**Chapter 4.1.1.3.4.1.**), and structure emplacement (**Chapter 4.1.1.3.3.2.**, Bottom Area Disturbance), as well as from a seafloor blowout (**Chapter 4.4.1.4.**). Potential impacts from blowouts on nonchemosynthetic communities are discussed in **Chapter 4.4.4.2.2.** These activities cause localized bottom disturbances and disruption of benthic communities in the immediate area. Considerable mechanical damage can be inflicted upon the bottom by routine OCS drilling activities. The physical disturbance by structures related to a drilling operation itself affects a small area of the sea bottom. These impacts are the same as those encountered in shallower continental shelf waters.

Anchors from support boats and ships (or, as assumed in these water depths, from any buoys set out to moor these vessels), floating drilling units, and pipelaying vessels also cause severe disturbances to small areas of the seafloor with the areal extent related to the size of the mooring anchor and length of chain that would rest on the bottom. Excessive scope (length) and movement of the mooring chain could disturb a much larger area of the bottom than would an anchor alone, depending on the prevailing wind and current directions. A 50-m radius of chain movement on the bottom around a mooring anchor could destroy communities in an area of nearly 8,000 m^2. A large area of bottom could also be disturbed by bottom contacts of the entire length of chain or cable for each anchor prior to and during the anchor cable tensioning from the central drilling structure. Larger anchors and additional scope of anchor chain are expected for operations in deep water as compared to operations on the shelf. Therefore, the areal extent of impacts, both for individual anchors and for the entire footprint, is expected to be greater for operations that employ anchoring in deep water. The area affected by anchoring operations would depend on the water depth, length of the chain, size of the anchor, and current. Many OCS-support operations and activities would not result in anchor impacts to deepwater benthic communities because vessels would tie-up directly to rigs, platforms, or mooring buoys or would use dynamic positioning. Anchoring would not necessarily directly destroy small infaunal organisms living within the sediment; the bottom disturbance would most likely change the environment to such an extent that the majority of the directly impacted infauna community would not survive (e.g., burial or relocation to sediment layers without sufficient oxygen). In cases of carbonate outcrops or reefs with attached epifauna, the impacted area of disturbance may be small in absolute terms, but it could be large in relation to the area inhabited by hard corals or other organisms that rely on exposed rock substrate.

As described in the previous section for chemosynthetic communities, normal pipelaying activities in deepwater areas could destroy large areas of benthic communities (it is assumed that 0.32 ha of bottom is disturbed per kilometer of pipeline installed.); although, without consideration of chemosynthetic organisms, there are no differences between this activity in deep water as compared to shallow-water operations.

In addition to direct physical impacts, structure removals and other bottom-disturbing activities could resuspend bottom sediments. The potential effects of resuspended bottom sediments are similar to those from the discharge of muds and cuttings discussed below.

Discharges

In deep water, discharges of drilling muds and cuttings at the surface are spread across broader areas of the seafloor and are, in general, distributed in thinner accumulations than in shallower areas on the continental shelf. Recent information about the effects of surface discharge of muds and cuttings at a well in 565 m is reported by Gallaway and Beaubien (1997) and is described in the previous section on chemosynthetic communities. In this instance and in another deepwater survey reported by Nunez (personal communication, 1994), muds and cuttings were documented in accumulations ranging up to 30 cm thick at distances up to 610 m from the well site.

Impact from muds and cuttings are also expected from two additional sources: (1) initial well drilling prior to the use of a riser to circulate returns to the surface; and (2) the potential use of various riserless drilling techniques in the deep sea. Jetted or drilled cuttings discharged at the bottom from the initial wellbore would total as much as 226 m^3 (Halliburton Company, 1995). In the case of some riserless drilling practices, all muds and cuttings from well spudding through total depth would be discharged at the seafloor. Although the full areal extent and depth of burial from these activities is not known, the potential impacts are expected to be localized and short term. Since these areas would occupy only a minuscule portion of the available seafloor in the deepwater GOM, these impacts are not considered significant provided that sensitive communities (e.g., chemosynthetic communities) are avoided.

Burial by sediments or rock fragments originating from drilling muds and cuttings discharges could smother and kill almost all community components of benthic organisms, with the exception of highly motile fish and possibly some crustaceans such as shrimp capable of moving away from the impacted area. Depending on the organism type, just a few centimeters of burial could cause death. The damage would be both mechanical and toxicological. Some types of macrofauna could burrow through gradual accumulations of overlying sediments depending on the toxicological effects of those added materials. Information on the potential toxic effects on various benthic organisms is limited and essentially nonexistent for deepwater taxa.

It can be expected that detrimental effects due to burial would decrease exponentially with distance from the origin. The physical properties of the naturally occurring surface sediment (grain size, porosity, and pore water) could also be changed as a result of discharges such that recolonizing benthic organisms would be comprised of different species than inhabited the area previous to the impact. Although the impacts could be considered severe to the nonmotile benthos in the immediate area affected, they would be considered very temporary. Due to the proximity of undisturbed bottom with similar populations of benthic organisms from microbenthos to megafauna, these impacts would be very localized and reversible at the population level and are not considered significant.

Carbonate outcrops not associated with chemosynthetic communities, such as the deepwater coral "reef" or habitat reported by Moore and Bullis (1960), are considered to be most at risk from oil and gas operations. Due to the fact that deepwater corals require hard substrate, existing communities completely buried by some amount of sediment would likely never recover.

Effluents other than muds or cuttings from routine OCS operations in deep water would be subject to rapid dilution and dispersion and are not projected to reach the seafloor at depths greater than 100 m.

Proposed Action Analysis

For a proposed action, two oil and gas structures are estimated to be installed. These deepwater production structures are expected to be installed 3-4 years after a proposed lease sale. Physical disturbance or destruction of a limited area of benthos or to a limited number of megafauna organisms, such as brittle stars, sea pens, or crabs, would not result in a major impact to the deepwater benthos ecosystem as a whole. Surface discharge of muds and cuttings, as opposed to seafloor discharge, would reduce or eliminate the impact of smothering the benthic communities on the bottom.

Under the current review procedures for chemosynthetic communities, carbonate outcrops are targeted as one possible indication (surface anomaly on 3D seismic survey data) that chemosynthetic seep communities are nearby. Unique communities that may be associated with any carbonate outcrops or other topographical features could be identified via this review along with the chemosynthetic communities. Typically, all areas suspected of being hard bottom are avoided as a geological hazard for any well sites. Any proposed activity in water depth greater than 400 m would automatically trigger the NTL 2000-G20 evaluation described above.

Summary and Conclusion

Some impact to soft-bottom, benthic communities from drilling and production activities would occur as a result of physical impact from structure placement (including templates or subsea completions), anchoring, and installation of pipelines regardless of their locations. Megafauna and infauna communities at or below the sediment/water interface would be impacted from the muds and cuttings normally discharged at the seafloor at the start of every new well prior to riser installation. The impact from muds and cuttings discharged at the surface are expected to be low in deep water. Drilling muds would not be expected to reach the bottom beyond a few hundred meters from the surface-discharge location, and cuttings would be dispersed. Even in situations where substantial burial of typical benthic 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.

Deepwater coral habitats and other potential high-density, 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 from OCS activities. Impacts to these sensitive habitats could permanently prevent recolonization with similar organisms requiring hard substrate; however, it is thought that deepwater hard-bottom communities are protected as an indirect result of the avoidance of potential chemosynthetic communities required by NTL 2000-G20. A new MMS-funded study of these habitats is planned in the near future.

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

4.2.1.5. Impacts on Marine Mammals

The major impact-producing factors resulting from the routine activities associated with a proposed action that may affect marine mammals include the degradation of water quality from operational discharges; noise generated by helicopters, vessels, seismic surveys, operating platforms, and drillships; vessel traffic; and jetsam and flotsam from service vessels and OCS structures. These major factors may affect marine mammals in the GOM at several temporal and spatial scales that result in acute or chronic impacts.

Discharges

Produced waters, drill muds, and drill cuttings are routinely discharged into offshore waters and contain trace metals (e.g., cadmium, chromium, lead, and mercury) and a suite of hazardous substances (e.g., sodium hydroxide, potassium hydroxide, ammonium chloride, hydrochloric acid, hydroflouric acid, and toluene). (See Boehm et al., 2001, or Ayers et al., 1980, for more complete lists.) Most operational discharges are diluted and dispersed when released offshore and are considered to have sublethal effects (API, 1989; NRC, 1983; Kennicutt, 1995). The impact to the environment is minimized through the permit requirements. The permit sets toxicity or volume limits on discharges. The permit sets a maximum concentration for several metals that are present in barite. The permit does allow the use of trace amounts of priority pollutants in well treatment, workover, and completion chemicals that are used downhole and on the surface as part of the produced water or waste drilling mud or cuttings stream.

Some hazardous chemicals are used offshore. Strong acid solutions are used to stimulate formation production. Corrosive base and salt solutions are used to maintain pH and condition the well. The acids, bases, and salts react with other waste streams and seawater and are gradually neutralized following use. Other chemicals, such as surfactants and solvents that may be toxic to aquatic life, are used in trace amounts. These chemicals often serve as carrier solutions to keep well treatment chemicals in a form so that they remain functional as it is pumped down the well. Biocides are used to prevent algal growth. These agents are preselected for use because of low toxicity, and in the case a biocide, a short half-life.

Contaminants may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of marine mammals or species lower in the marine food web. Marine mammals generally are inefficient assimilators of petroleum compounds in prey (Neff, 1990). Analyses of samples from stranded GOM bottlenose dolphins showed high levels of organochlorides and heavy metals (e.g., Salata et al., 1995; Kuehl and Haebler, 1995). Many heavy metals presumably are acquired from food, but the ultimate sources are poorly known (API, 1989). Adequate baseline data is not available to determine the significant sources of contaminants that accumulate in GOM cetaceans or their prey, due in no small part to the fact that contaminants are introduced into the GOM from a suite of national and international watersheds. Many cetaceans are wide-ranging animals, which also compounds the problem. There is, in many cases, a striking difference between the relatively high mercury levels in the toothed whales and the lower levels found in baleen whales, which is probably attributable to the different prey species consumed by baleen whales, as well as differences in the habitat (Johnston et al., 1996). It is also known that neritic cetacean species tend to have higher levels of some metals than those frequenting oceanic waters (Johnston et al., 1996). Oceanic cetaceans (e.g., sperm whales) feeding on cephalopods (e.g., squid) have higher levels of cadmium in their tissues than comparable fish-eating species (Johnston et al., 1996). Squid are attributed with the ability to retain some trace metals such as cadmium, copper and zinc, as well as polycyclic aromatic hydrocarbons (Reijnders and Aguilar, 2002). Therefore, sperm whales and other cetaceans that feed on squid in the northern GOM may be predisposed to bioaccumulating contaminants.

Aircraft

Aircraft overflights in proximity to cetaceans can elicit a startle response. Whales often react to aircraft overflights by hasty dives, turns, or other abrupt changes in behavior. Responsiveness varies widely depending on factors such as the activity the animals are engaged in and water depth (Richardson et al., 1995). Whales engaged in feeding or social behavior are often insensitive to overflights. Whales in confined waters, or those with calves, sometimes seem more responsive. This behavioral response could be a result of noise and/or visual disturbance. The effects appear to be transient, and there is no indication that long-term displacement of whales occur. Absence of conspicuous responses to an aircraft does not show that the animals are unaffected; it is not known whether these subtle effects are biologically significant (Richardson and Würsig, 1997).

Vessel Traffic

Of 11 species known hit by vessels, fin whales are struck most frequently, sperm whales are hit commonly, and records of collisions with Bryde's whales are rare (Laist et al., 2001). Fin whales are rare, sperm whales are common, and Bryde's whales are uncommon in the GOM. Data compiled of 58 collisions indicate that all sizes and types of vessels can collide with whales; the majority of collisions appear to occur over or near the continental shelf; most lethal or severe injuries are caused by ships 80 m or longer; whales usually are not seen beforehand or are seen too late to be avoided; and most lethal or severe injuries involve ships traveling 14 knots (kn) or faster. Vessel collisions can significantly affect small populations of whales, such as northern right whales in the western North Atlantic (Laist et al., 2001).

Increased traffic from support vessels involved in survey, service, or shuttle functions would increase the probability of collisions between vessels and marine mammals occurring in the area. These collisions can cause major wounds on cetaceans and/or be fatal (e.g., northern right whale, Kraus, 1990, and Knowlton et al., 1997; bottlenose dolphin, Fertl, 1994; sperm whale, Waring et al., 1997). Debilitating injuries may have negative effects on a population through impairment of reproductive output. Slow-moving cetaceans (e.g., northern right whale) or those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., sperm whale) might be expected to be the most vulnerable. Smaller delphinids often approach vessels that are in transit to bow-ride. It would seem that delphinids are agile enough to easily avoid being struck by vessels. However, there are occasions that dolphins are either not attentive (due to behaviors they are engaged in or perhaps because of their age/health) or there is too much vessel traffic around them, and they are struck by screws. Nowacek and Wells (2001) found that bottlenose dolphins had longer interbreath intervals during boat approaches compared to control periods (no boats present within 100 m) in a study conducted in Sarasota Bay, Florida. They also found that dolphins decreased interanimal distance, changed heading, and increased swimming speed significantly more often in response to an approaching vessel than during control periods.

Toothed whales (and baleen whales, to a lesser extent) show some tolerance of vessels, but may react at distances of several kilometers or more when confined by environmental features or when they learn to associate the vessel with harassment. Evidence suggests that certain whales have reduced their use of certain areas heavily utilized by ships (Richardson et al., 1995), possibly avoiding or abandoning important feeding areas, breeding areas, resting areas, or migratory routes. The continued presence of various cetacean species in areas with heavy boat traffic indicates a considerable degree of tolerance to ship noise and disturbance. An experiment involving playback of low-frequency sound in the Canary Islands suggests that sperm whales from an area that has heavy vessel traffic have a high tolerance for noise (Andre et al., 1997). There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or growth, unless they occur frequently.

Long-term displacement of animals, in particular baleen whales, from an area is also a possibility. It is not known whether toothed whales exposed to recurring vessel disturbance are stressed or otherwise affected in a negative, but inconspicuous way (Richardson et al., 1995). Stress or "alert" responses could occur quite early during an encounter. For example, Myrick and Perkins (1995) found stress responses occurring as early as the chase stage in purse-seine netting on dolphins.

It is possible that manatees could occur in coastal areas where vessels traveling to and from the leased sites could affect them. If a manatee should be present where there is vessel traffic, they could be injured or killed by a boat striking them (Wright et al., 1995). Inadequate hearing sensitivity at low frequencies may be a contributing factor to the manatees' inability to effectively detect boat noise and avoid collisions with boats (Gerstein et al., 1999).

Drilling and Production Noise

Exploration, delineation, and production structures, as well as drillships, produce an acoustically wide range of sounds at frequencies and intensities that can be detected by cetaceans. Some of these sounds could mask cetaceans' reception of sounds produced for echolocation and communication. Odontocetes use sounds at frequencies that are generally higher than the dominant sounds generated by offshore drilling and production activities. Low-frequency hearing has not been studied in many species, but bottlenose dolphins can hear sounds at frequencies as low as 40-125 Hz. Below 1 kHz, where most OCS-industry noise energy is concentrated, sensitivity seems poor (Richardson et al., 1995). Pilot whales and sperm whales changed their behavior (in particular, ceased vocalizations) during low-frequency transmissions from the Heard Island Feasibility Test in the southern Indian Ocean (Bowles et al., 1994); this throws doubt on the assumed insensitivity of odontocete hearing at low frequencies. Baleen whales mainly utter low-frequency sounds that overlap broadly with the dominant frequencies of many OCS-industry sounds. There are indirect indications that baleen whales are sensitive to low- and moderate-frequency sounds (Richardson et al., 1995). Drilling noise from conventional metal-legged structures and semisubmersibles is not particularly intense and is strongest at low frequencies, averaging 5 Hz and 10-500 Hz, respectively (Richardson et al., 1995). There is particular concern for baleen whales that are apparently more dependent on low-frequency sounds than are other marine mammals; many industrial sounds are concentrated at low frequencies. Drillships produce higher levels of underwater noise than other types of platforms. There are few published data on underwater noise levels near production platforms and on the marine mammals near those facilities (Richardson et al., 1995). However, underwater strong noise levels may often be low, steady, and not very disturbing (Richardson et al., 1995). Stronger reactions would be expected when sound levels are elevated by support vessels or other noisy activities (Richardson et al., 1995).

Human-made sounds may affect the ability of marine mammals to communicate and to receive information about their environment (Richardson et al., 1995). Such noise may interfere with or mask the sounds used and produced by these animals and thereby interfere with their natural behavior. These sounds may frighten, annoy, or distract marine mammals and lead to physiological and behavioral disturbances. Response threshold may depend on whether habituation (gradual waning of behavioral responsiveness) or sensitization (increased behavioral responsiveness) occurs (Richardson et al., 1995). Sounds can cause reactions that might include disruption of marine mammals' normal activities (behavioral and/or social disruption) and, in some cases, short- or long-term displacement from areas important for feeding and reproduction (Richardson et al., 1995). The energetic consequences of one or more disturbance-induced periods of interrupted feeding or rapid swimming, or both, have not been evaluated quantitatively. Energetic consequences would depend on whether suitable food is readily available. Of the animals responding to noise, females in late pregnancy or lactating would probably be most affected. Human-made noise may cause temporary or permanent hearing impairment in marine mammals if the noise is strong enough. Such impairment would have the potential to diminish the individual's chance for survival. Tolerance of noise is often demonstrated, but this does not prove that the animals are unaffected by noise; for example, they may become stressed, making the animal(s) more vulnerable to parasites, disease, environmental contaminants, and/or predation. Noise-induced stress is possible, but little studied in marine mammals. Aversive levels of noise might cause animals to become irritable, affecting feed intake, social interactions, or parenting; all of these effects might eventually result in population declines (Bowles, 1995).

Seismic Surveys

The MMS has almost completed a programmatic EA on G&G permit activities in the GOM (USDOI, MMS, in preparation). The EA includes a detailed description of the seismic surveying technologies, energy output, and operations; these descriptions are incorporated here by reference. Seismic surveys use a high-energy noise source. During Irish Sea seismic surveys, pulses were audible on hydrophone recordings above the highly elevated background ship noise at least up to the 20-km range (Goold and Fish, 1998). Although the output of airgun arrays is usually tuned to concentrate low-frequency energy, a broad frequency spectrum is produced, with significant energy at higher frequencies (e.g., Goold and Fish, 1998). These energies encompass the entire audio frequency range of 20 Hz to 20 kHz (Goold and Fish, 1998) and extend well into the ultrasonic range up to 50 kHz.

Baleen whales seem quite tolerant of low- and moderate-level sound pulses from distant seismic surveys but exhibit behavioral changes in the presence of nearby seismic activity (Richardson et al., 1995). Subtle effects on surfacing, respiration, and dive cycles have been noted (Richardson et al., 1995; Richardson, 1997). Response appears to diminish gradually with increasing distance and decreasing sound level (Richardson, 1997). Bowhead and gray whales often show strong avoidance within 6-8 km of an airgun array. Humpback whales off western Australia were found to change course at 3-6 km from an operating seismic survey vessel, with most animals keeping a standoff range of 3-4 km (McCauley et al., 1998a and b). Humpback whale groups containing females involved in resting behavior in key habitat types were more sensitive than migrating animals and showed an avoidance response estimated at 7-12 km from a large seismic source (McCauley et al., 2000). Whales exposed to sound from distant seismic survey ships may be affected even though they remain in the area and continue their normal activities (Richardson et al., 1995). For baleen whales, in particular, it is not known (1) whether the same individuals return to areas of previous seismic exposure, (2) whether seismic work has caused local changes in distribution or migration routes, or (3) whether whales that tolerate strong seismic pulses are stressed (Richardson et al., 1995). Individually identified gray whales remained in Puget Sound long after the seismic survey (as is normal), despite being exposed to noise (Calambokidis and Osmek, 1998; Bain et al., 1999).

Goold (1996) found that acoustic contacts with common dolphins in the Irish Sea dropped sharply as soon as seismic activity began, suggesting a localized disturbance of dolphins. It was also estimated that seismic energy from the 2,120-in^3 airgun array in a shelf sea environment was safe to common dolphins at a radius from the gun array of 1 km (Goold and Fish, 1998). Given the high, broadband seismic-pulse power levels across the entire recorded bandwidth and the known auditory thresholds for several dolphin species, Goold and Fish (1998) considered such seismic emissions to be clearly audible to dolphins across a bandwidth of tens of kilohertz and at least out to the 8-km range.

Sperm whales during the Heard Island Feasibility Test were found to cease calling during some (but not all) times when seismic pulses were received from an airgun array more than 300 km away (Bowles et al., 1994) (whether sperm whales were responding directly to the seismic pulses is not known). In contrast, there are observations of sperm whales in the GOM continuing to vocalize while seismic pulses are ongoing (Evans, personal communication, 1999). One report of GOM sperm whales suggested that the animals may have moved 50+ km away in response to seismic pulses (Mate et al., 1994), but further work suggests that the animals may not have moved in response to the sound, but perhaps relative to oceanographic features and prey distribution. It is unclear whether the well-documented, continued occurrence of sperm whales in the area off the mouth of the Mississippi River is a consequence of low sensitivity to seismic sound or a high motivation to remain in the area. Sperm whales have historically occupied this area; their continued presence might suggest habituation to the seismic signals. During the MMS-sponsored GulfCet II study on marine mammals, results showed that the cetacean sighting rate did not change significantly due to seismic exploration signals (Davis et al., 2000). The analysis of the results was unable to detect small-scale (<100 km) changes in cetacean distribution. Results of passive acoustic surveys to monitor sperm-whale vocal behavior and distribution in relation to seismic surveys in the northeastern Atlantic revealed few, if any, effects of airgun noise (Swift et al., 1999). The authors suggested that sperm whales in that area may be habituated to seismic surveys and/or responses may occur at scales to which the research was not sensitive.

No obvious behavior modifications relative to the seismic activity were recorded during the majority of the small odontocete observations made during marine mammal monitoring carried out during a 3D seismic survey offshore California in late 1995 (Arnold, 1996). There was also no observable behavior modification or harassment of large whales attributable to the sound effects of the survey (Arnold, 1996).

There are no data on auditory damage in marine mammals relative to received levels of underwater sound pulses (Richardson et al., 1995). Indirect "evidence" suggests that extended or repeated exposure to seismic pulses is unlikely to cause permanent hearing damage in marine mammals given a study of damage risk criteria; the transitory nature of seismic exploration; the presumed ability of marine mammals to tolerate exposure to strong calls from themselves or other nearby mammals; and the avoidance responses that occur in at least some baleen whales, when exposed to certain levels of seismic pulses (Richardson et al., 1995).

Flotsam and Jetsam

In recent years, there has been increasing concern about manmade debris (discarded from offshore and coastal sources) and its impact on the marine environment (e.g., Shomura and Godfrey, 1990; Laist, 1997). Both entanglement in and ingestion of debris has caused the death or serious injury of marine mammals (Heneman and the Center for Environmental Education, 1988; MMC, 1998). The debris items most often found entangling animals are net fragments and monofilament line from commercial and recreational fishing boats, as well as strapping bands and ropes probably from all types of vessels. Plastic bags and small plastic fragments are the most commonly reported debris items in the digestive tracts of cetaceans and manatees (e.g., Barros and Odell, 1990; Tarpley and Marwitz, 1993; Laist, 1997; MMC, 1998). Many types of plastic materials are used during drilling and production activities; the offshore oil and gas industry was shown to contribute 13 percent of the debris found at Padre Island National Seashore (Miller et al., 1995). The MMS prohibits the disposal of equipment, containers, and other materials into coastal and offshore waters by lessees (30 CFR 250.40). Prohibition of the discharge and disposal of vessel- and offshore structure-generated garbage and solid waste items into both offshore and coastal waters was established January 1, 1989, via the enactment of MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which the USCG enforces. Accidental release of debris from OCS activities is known to occur offshore, and such flotsam may injure or kill cetaceans.

Proposed Action Analysis

The major impact-producing factors affecting marine mammals as a result of routine OCS activities as a result of a proposed action include the degradation of water quality from operational discharges; noise generated by helicopters, vessels, operating platforms, and drillships; vessel traffic; seismic surveys; and jetsam and flotsam from service vessels and OCS structures.

Information on drilling fluids, drill cuttings, and produced waters that would be discharged offshore as a result of a proposed action is provided in **Chapter 4.1.1.4.**, Operational Waste Discharged Offshore. Some effluents are routinely discharged into offshore marine waters. It is expected that cetaceans may have some interaction with these discharges. Direct effects to cetaceans are expected to be sublethal. It should be noted, however, that any pollution in the effluent could poison and kill or debilitate marine mammals and adversely affect the food chains and other key elements of the GOM ecosystem (Tucker & Associates, Inc., 1990). Because OCS discharges are diluted and dispersed in the offshore environment, impacts to cetaceans are expected to be negligible.

Helicopter activity projections are 7,000-9,000 trips over the life of a proposed action (**Table 4-2**) or 180-230 trips annually. The FAA Advisory Circular 91-36C encourages pilots to maintain higher than minimum altitudes (noted below) over noise-sensitive areas. Corporate helicopter policy states that helicopters should maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms. In addition, guidelines and regulations promulgated by NOAA Fisheries under the authority of the Marine Mammal Protection Act do include provisions specifying helicopter pilots to maintain an altitude of 1,000 ft within 100 yd (91 m) of marine mammals. It is unlikely that cetaceans would be affected by routine OCS helicopter traffic operating at these altitudes, provided pilots do not alter their flight patterns to more closely observe or photograph marine mammals that they see. It is expected that about 10 percent of helicopter trips would occur at altitudes below the specified minimums listed above as a result of inclement weather. Routine overflights may elicit a startle response from, and interrupt cetaceans nearby (depending on the activity of the animals) (Richardson et al., 1995). Occasional overflights probably have no long-term consequences on cetaceans; however, frequent overflights could have long-term consequences if they repeatedly disrupt vital functions, such as feeding and breeding. Frequent overflights are expected in coastal and Federal neritic waters. Generally, overflights become less frequent as the distance from shore of the OCS facilities being serviced increases; however, many offshore fields are supported by resident helicopters, resulting in increased localized overflights. The area supported by a resident helicopter is dependent in part on the size of the field that it supports. Temporary disturbance to cetaceans may occur on occasion as helicopters approach or depart OCS facilities, if animals are near the facility. Such disturbance is believed negligible.

An estimated 8,000-9,000 OCS-related, service-vessel trips are expected to occur over the life of a proposed action (**Table 4-2**). The rate of trips would be about 205-230 trips/yr. Noise from service-vessel traffic may elicit a startle and/or avoidance reaction from cetaceans or mask their sound reception. There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or productivity. Long-term displacement of animals from an area is also a consideration. It is not known whether toothed whales exposed to recurring vessel disturbance would be stressed or otherwise affected in a negative but inconspicuous way. Increased ship traffic could increase the probability of collisions between ships and marine mammals, resulting in injury or death to some animals. Smaller delphinids may approach vessels that are in transit to bow-ride. Limited observations on an NOAA Fisheries cruise off the mouth of the Mississippi River in the summer of 2000 indicated that sperm whales appeared to avoid passing service vessels. However, marine mammalogists conducting surveys in the CPA during the summer of 2001 documented an adult killer whale that bore conspicuous and aged scarring across its back that were indubitably the result of a collision with a motor vessel. A manatee was unintentionally hit and killed by a boat off Louisiana (Schiro et al., 1998). Another manatee was killed by vessel traffic (type of vessel unknown) in Corpus Christi Bay in October 2001 (Beaver, personal communication, 2001). It appears there is limited threat posed to smaller, coastal delphinids where the majority of OCS vessel traffic occurs; however, as exploration and development of petroleum resources in oceanic waters of the northern GOM increases, OCS vessel activity would increase in these waters, thereby increasing the risk of vessel strike to sperm whales and other deep-diving cetaceans (e.g., *Kogia* and beaked whales). Deep-diving whales are more vulnerable to vessel strikes because of the extended surface period required to recover from extended deep dives. Cetaceans engaging in social activity at or near the surface may be distracted by their associates and not detect approaching vessel traffic, making them more susceptible to vessel strikes. Manatees are uncommon to common in the central and eastern GOM, respectively. Manatees are not known to frequent oceanic waters of the GOM where OCS exploration and production operations associated with a proposed action would occur. Consequently, there is little risk posed by OCS vessel traffic in the EPA, although animals occurring in

State waters of the Central and Eastern GOM may be more vulnerable to vessel strikes from service vessels transiting to and from offshore exploration and production projects.

A total of 11-13 exploration wells and 19-27 development wells are projected to be drilled as a result of a proposed action (**Table 4-2**). Two production structures are projected to be installed as a result of a proposed action (**Table 4-2**). These wells and platforms could produce sounds at intensities and frequencies that could be heard by cetaceans. It is expected that noise from drilling activities would be relatively constant and last no longer than four months per well. Odontocetes echolocate and communicate at higher frequencies than the dominant sounds generated by drilling platforms. Sound levels in this range are not expected to be generated by drilling operations (Gales, 1982). Bottlenose dolphins, one of the few species in which low-frequency sound detection has been studied, have been found to have poor sensitivity levels at the level where most industrial noise energy is concentrated. There is some concern for baleen whales since they are apparently more dependent on low-frequency sounds than other marine mammals; however, except for the Bryde's whale, baleen whales are extralimital or accidental in occurrence in the GOM. During GulfCet surveys, Bryde's whale was sighted north and east of the proposed lease sale area; these sightings were in waters deeper than 100 m (Davis et al., 2000). Bryde's whale would likely be subjected to OCS drilling and production noise. Potential effects on GOM marine mammals include disturbance (subtle changes in behavior, interruption of previous activities, or short- or long-term displacement); masking of calls from conspecifics, reverberations from own calls, and other natural sounds (e.g., surf, predators); stress (physiological); and hearing impairment (permanent or temporary) by explosions and strong nonexplosive sounds.

Many types of materials, including plastics, are used during drilling and production operations. Some materials are accidentally lost overboard where cetaceans can consume it or become entangled in it. Entanglement with or ingestion of some materials lost overboard could be lethal; however, the probabilities of occurrence, ingestion, entanglement, and lethal effect are unknown.

Summary and Conclusion

Small numbers of marine mammals could be killed or injured by chance collision with service vessels, or by entanglement with or consumption of trash and debris lost from service vessels, drilling rigs, and fixed and floating platforms. Deaths due to structure removals are not expected. There is no conclusive evidence whether anthropogenic noise has or has not caused long-term displacements of, or reductions in, marine mammal populations. Contaminants in waste discharges and drilling muds might indirectly affect marine mammals through food-chain biomagnification, although the scope of effects and their magnitude are not known.

The routine activities of a proposed action is not expected to have long-term adverse effects on the size and productivity of any marine mammal species or population stock endemic to the northern GOM.

4.2.1.6. Impacts on Sea Turtles

The major impact-producing factors resulting from the routine activities associated with a proposed action that may affect loggerhead, Kemp's ridley, hawksbill, green, and leatherback turtles include water-quality degradation from operational discharges; noise from helicopter and vessel traffic, seismic surveys, operating platforms, and drillships; vessel collisions; brightly-lit platforms;; and OCS-related trash and debris.

Discharges

Produced waters, drill muds, and drill cuttings are routinely discharged into offshore waters and contain trace metals (e.g., cadmium, chromium, lead, and mercury) and a suite of hazardous substances (e.g., sodium hydroxide, potassium hydroxide, ammonium chloride, hydrochloric acid, hydroflouric acid, and toluene). (See Boehm et al., 2001, or Ayers et al., 1980, for more complete lists.) Most operational discharges are diluted and dispersed when released offshore and are considered to have sublethal effects (API, 1989; NRC, 1983; Kennicutt, 1995). The impact to the environment is minimized through the USEPA's NPDES permit requirements. The permit sets toxicity or volume limits on discharges. The permit sets a maximum concentration for several metals that are present in barite. The permit does allow the use of trace amounts of priority pollutants in well treatment, workover, and completion chemicals that are used downhole and on the surface as part of the produced water or waste drilling mud or cuttings stream.

Some hazardous chemicals are used offshore. Strong acid solutions are used to stimulate formation production. Corrosive base and salt solutions are used to maintain pH and condition the well. The acids, bases, and salts react with other waste streams and seawater and are gradually neutralized following use. Other chemicals, such as surfactants and solvents that may be toxic to aquatic life, are used in trace amounts. These chemicals often serve as carrier solutions to keep well treatment chemicals in a form so that they remain functional as it is pumped down the well. Biocides are used to prevent algal growth. These agents are preselected for use because of low toxicity and, in the case a biocide, a short half-life. Sea turtles may have some interaction with these discharges. Contaminants in discharges could contribute to the poisoning of sea turtles and, over time, kill or debilitate sea turtles or adversely affect the food chains and other key elements of the GOM ecosystem. Contaminants may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of sea turtles or species lower in the marine food web (for further information on bioaccumulation, see **Chapter 4.1.1.4.**, Operational Waste Discharged Offshore). Sea turtles may bioaccumulate chemicals such as heavy metals that occur in drilling muds. This might ultimately reduce reproductive fitness in the turtles, an impact that the already diminished population(s) cannot tolerate. Samples from stranded turtles in the GOM carry high levels of organochlorides and heavy metals (Sis et al., 1993). Because OCS discharges are diluted and dispersed in the offshore environment and are but one of multiple sources of contaminants introduced into the northern GOM, impacts to sea turtles from operational discharges are at most regarded as adverse but not significant.

Noise

There are no systematic studies published of the reactions of sea turtles to aircraft overflights, and anecdotal reports are scarce. However, it is assumed that aircraft noise could be heard by a sea turtle at or near the surface and cause the animal to alter its normal behavior pattern (Advanced Research Projects Agency, 1995). Noise from service-vessel traffic may elicit a startle reaction from sea turtles and produce a temporary sublethal stress (NRC, 1990). Startle reactions may result in increased surfacings, possibly causing an increase in risk of vessel collision. Reactions to aircraft or vessels, such as avoidance behavior, may disrupt normal activities, including feeding. Important habitat areas (e.g., feeding, mating, and nesting) may be avoided due to noise generated in the vicinity. There is no information regarding the consequences that these disturbances may have on sea turtles in the long term. If sound affects any prey species, impacts to sea turtles would depend on the extent that prey availability might be altered.

Drilling and production facilities produce an acoustically wide range of sounds at frequencies and intensities that could possibly be detected by turtles. Drilling noise from conventional metal-legged structures and semisubmersibles is not particularly intense and is strongest at low frequencies (Richardson et al., 1995). Sea turtle hearing sensitivity is not well studied. A few preliminary investigations using adult green, loggerhead, and Kemp's ridley turtles suggest that they are most sensitive to low-frequency sounds (Ridgway et al., 1969; Lenhardt et al., 1983; Moein Bartol et al., 1999). It has been suggested that sea turtles use acoustic signals from their environment as guideposts during migration and as a cue to identify their natal beaches (Lenhardt et al., 1983). Bone-conducted hearing appears to be a reception mechanism for at least some of the sea turtle species, with the skull and shell acting as receiving structures (Lenhardt et al., 1983).

Noise-induced stress has not been studied in sea turtles. Captive loggerhead and Kemp's ridley turtles exposed to brief, audio-frequency vibrations initially showed startle responses of slight head retraction and limb extension (Lenhardt et al., 1983). Sound-induced swimming has been observed for captive loggerheads and greens (O'Hara and Wilcox, 1990; Moein Bartol et al., 1993; Lenhardt, 1994). Some loggerheads exposed to low-frequency sounds responded by swimming towards the surface at the onset of the sound, presumably to lessen the effects of the transmissions (Lenhardt, 1994). Sea turtles have been seen to begin to noticeably increase their swimming in response to an operating seismic source at 166 dB re-1µPa-m (measurement of sound level in water) (McCauley et al., 2000). The MMS has almost completed a programmatic EA on G&G permit activities in the GOM (USDOI, MMS, in preparation). The EA includes a detailed description of the seismic surveying technologies, energy output, and operations; these descriptions are incorporated here by reference. An anecdotal observation of a free-ranging leatherback's response to the sound of a boat motor suggests that leatherbacks may be sensitive to low-frequency sounds, but the response could have been to mid- or high-frequency components of the sound (Advanced Research Projects Agency, 1995). The potential direct and indirect impacts of sound on sea turtles include physical auditory effects (temporary threshold shift), behavioral disruption, long-term effects, masking, and adverse impacts on the food chain. Low-frequency sound transmissions could potentially cause increased surfacing and avoidance from the area near the sound source (Lenhardt et al., 1983; O'Hara and Wilcox, 1990; McCauley et al., 2000). The potential for increased surfacing could place turtles at greater risk of vessel collisions and potentially greater vulnerability to natural predators.

Vessel Collisions

Data show that vessel traffic is one cause of sea turtle mortality in the GOM (Lutcavage et al., 1997). Stranding data for the Gulf and Atlantic Coasts, Puerto Rico, and the U.S. Virgin Islands show that between 1986 and 1993 about 9 percent of living and dead stranded sea turtles had boat strike injuries (n=16, 102) (Lutcavage et al., 1997). However, vessel-related injuries were noted in 13 percent of stranded turtles examined from strandings in the GOM and on the Atlantic Coast during 1993 (Teas, 1994), but this figure includes those that may have been struck by boats post-mortem. In Florida, where coastal boating is popular, 18 percent of strandings documented between 1991 and 1993 were attributed to vessel collisions (Lutcavage et al., 1997). Large numbers of loggerheads and 5-50 Kemp's ridley turtles are estimated to be killed by vessel traffic per year in the U.S. (NRC, 1990; Lutcavage et al., 1997). Numbers of OCS-related vessel collisions with sea turtles offshore are unknown, but it is expected that some sea turtles would be impacted.

Brightly-lit Platforms

Brightly-lit, offshore drilling facilities present a potential danger to hatchlings (Owens, 1983). Hatchlings are known to be attracted to light (Raymond, 1984; Witherington and Martin, 1996; Witherington, 1997) and may orient toward lighted offshore structures (Chan and Liew, 1988). If this occurs, hatchling predation might increase dramatically since large birds and predatory fishes also congregate around structures (Owens, 1983; Witherington and Martin, 1996).

Jetsam and Flotsam

A wide variety of trash and debris is commonly observed in the GOM. Marine trash and debris comes from a variety of land-based and ocean sources (Cottingham, 1988). Some material is accidentally lost during drilling and production operations. From March 1, 1994, to February 28, 1995, a total of 40,580 debris items were collected in a 16-mi transect made along the Padre Island National Seashore (Miller et al., 1995). The offshore oil and gas industry was shown to contribute 13 percent of the trash and debris found in the transect. Turtles may become entangled in drifting debris and ingest fragments of synthetic materials (Carr, 1987; USDOC, NOAA, 1988; Heneman and the Center for Environmental Education, 1988). Entanglement usually involves fishing line or netting (Balazs, 1985). Once entangled, turtles may drown, incur impairment to forage or avoid predators, sustain wounds and infections from the abrasive or cutting action of attached debris, or exhibit altered behavior that threaten their survival (Laist, 1987). Both entanglement and ingestion have caused the death or serious injury of individual sea turtles (Balazs, 1985). Balazs (1985) compiled dozens of records of sea turtle entanglement, ingestion, and impaction of the alimentary canal by ingested plastics, although tar was the most common item ingested. The marked tendency of leatherbacks to ingest plastic has been attributed to misidentification of the translucent films as jellyfish. Lutz (1990) concluded that turtles would actively seek out and consume plastic sheeting. Ingested debris may block the digestive tract or remain in the stomach for extended periods, thereby lessening the feeding drive, causing ulcerations and injury to the stomach lining, or perhaps even providing a source of toxic chemicals (Laist, 1987). Weakened animals are then more susceptible to predators and disease; they are also less fit to migrate, breed, or nest successfully.

The initial life history of sea turtles involves the hatching of eggs, evacuation of nests, and commencement of an open-ocean voyage. Some hatchlings spend their "lost years" in sargassum rafts; ocean currents concentrate or trap floating debris in sargassum (Carr, 1987). Witherington (1994) studied post-hatchling loggerheads in drift lines 8-35 nmi east of Cape Canaveral and Sebastian Inlet, Florida.

Out of 103 turtles captured, 17 percent of the animals contained plastic or other synthetic fibers in their stomachs or mouths. The GOM had the second highest number of turtle strandings affected by debris (35.9%) (Witzell and Teas, 1994). Although the Kemp's ridley is the second most commonly stranded turtle, they are apparently less susceptible to the adverse impacts of debris than the other turtle species for some unknown reason (Witzell and Teas, 1994). The MMS prohibits the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458) prohibits the disposal of any plastics at sea or in coastal waters.

Proposed Action Analysis

Information on drilling fluids, drill cuttings, and produced waters that would be discharged offshore as a result of a proposed action is provided in **Chapter 4.1.1.4.**, Operational Waste Discharged Offshore. These effluents are routinely discharged into offshore marine waters and are regulated by the USEPA's NPDES permits. Turtles may have some interaction with these discharges. Very little information exists on the impact of drilling muds on GOM sea turtles (Tucker and Associates, Inc., 1990).

Structure installation, pipeline placement, dredging, and water quality degradation can impact seagrass bed and live-bottom communities that sea turtles sometimes inhabit. These impacts are analyzed in detail in **Chapter 4.2.1.3.**, Impacts on Sensitive Coastal Environments. A discussion of the causes and magnitude of wetland loss as a result of a proposed action can be found in **Chapter 4.2.1.3.2.** The seagrass and high-salinity marsh components of wetland loss would be indirectly important for sea turtles by reducing the availability of forage species that rely on these sensitive habitats. Little or no damage is expected to the physical integrity, species diversity, or biological productivity of live-bottom marine turtle habitat as a result of a proposed action because these sensitive resources are protected by several mitigation measures established by MMS.

An estimated 8,000-9,000 OCS-related, service-vessel trips are expected to occur over the life of a proposed action (**Table 4-2**). The rate of trips would be about 200-225 trips/yr. Transportation corridors would be through areas where sea turtles have been sighted. Helicopter activity projections are 7,000-9,000 trips over the life of a proposed action (**Table 4-2**) or 175-225 trips annually. Noise from service-vessel traffic and helicopter overflights may elicit a startle reaction from sea turtles; there is the possibility of short-term disruption of activity patterns. Sounds from approaching aircraft are detected in the air far longer than in water. For example, an approaching Bell 214ST helicopter became audible in the air more than four minutes before passing overhead, while it was detected underwater for only 38 seconds at 3-m depth and for 11 seconds at 18-m depth (Richardson et al., 1995). There are no systematic studies published concerning the reactions of sea turtles to aircraft overflights, and anecdotal reports are scarce. It is assumed that aircraft noise could be heard by a sea turtle at or near the surface and could cause it to alter its activity (Advanced Research Projects Agency, 1995). In the wild, most sea turtles spend at least 3-6 percent of their time at the surface. Despite the brevity of their respiratory phases, sea turtles sometimes spend as much as 19-26 percent of their time at the surface, engaged in surface basking, feeding, orientation, and mating (Lutcavage et al., 1997). Sea turtles located in shallower waters have shorter surface intervals, whereas turtles occurring in deeper waters have longer surface intervals. It is not known whether turtles exposed to recurring vessel disturbance would be stressed or otherwise affected in a negative but inconspicuous way. Migratory corridors used by sea turtles may be impacted by increased vessel and aircraft disturbance. Increased vessel traffic would increase the probability of collisions between vessels and turtles, potentially resulting in injury or death to some animals.

A total of 11-13 exploratory wells and 19-27 development wells are projected to be drilled as a result of a proposed action (**Table 4-2**). Two production structures are projected as a result of a proposed action (**Table 4-2**). These structures could generate sounds at intensities and frequencies that could be heard by turtles. There is some evidence suggesting that turtles may be receptive to low-frequency sounds, which is at the level where most industrial noise energy is concentrated. Potential effects on turtles include disturbance (subtle changes in behavior, interruption of activity), masking of other sounds (e.g., surf, predators, and vessels), and stress (physiological).

Sea turtles can become entangled in or ingest debris produced by exploration and production activities resulting from a proposed action. Turtles that mistake plastic for jellyfish may be more vulnerable to gastrointestinal blockage, resulting in their starvation. Turtles entangled in debris may drown or may be impaired in their ability to swim, dive, forage or mate. The probability of plastic ingestion/entanglement is unknown.

Summary and Conclusion

Routine activities resulting from a proposed action have the potential to harm individual sea turtles. These animals could be impacted by the degradation of water quality resulting from operational discharges; noise generated by helicopter and vessel traffic, platforms, and drillships; brightly-lit platforms;; vessel collisions; and jetsam and flotsam generated by service vessels and OCS facilities. Lethal effects are most likely to be from chance collisions with OCS service vessels, ingestion of debris, or entanglement in flotsam. Most OCS activities are expected to have sublethal effects. Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification; there is uncertainty concerning the possible effects. Chronic sublethal effects (e.g., stress) resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas could cause declines in survival or fecundity, and result in population declines, however, such declines are not expected. The routine activities of a proposed action are unlikely to have significant adverse effects on the size and recovery of any sea turtle species or population in the GOM.

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

The Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice are designated as protected species under the Endangered Species Act of 1973 (**Chapter 1.3.**, Regulatory Framework). The mice occupy restricted habitat behind coastal foredunes of Florida and Alabama (Ehrhart, 1978; USDOI, FWS, 1987). Portions of the beach mouse habitat have been designated as critical.

Proposed Action Analysis

The major impact-producing factors associated with a proposed action that may affect beach mice include beach trash and debris, efforts undertaken for the removal of marine debris or for beach restoration, offshore and coastal oil spills, and spill-response activities. The potential impacts from spills on beach mice and spill-response activities are discussed in **Chapter 4.4.7.**

Beach mice may mistakenly consume trash and debris. Mice may become entangled in the debris. A proposed action in the EPA is expected to contribute negligible marine debris or disruption to beach mice areas. Efforts undertaken for the removal of marine debris or for beach restoration, such as sand replenishment, may temporarily scare away beach mice, destroy their food resources such as sea oats, or collapse the tops of their burrows.

Trash and debris from a proposed action could reach the salt marsh area where the vole lives, based on drifter studies in the GOM (Lugo-Fernandez et al., 2001). Major routine impact-producing factors and potential effects on the salt marsh vole are similar to those discussed above for beach mice.

Summary and Conclusion

An impact from a proposed action on the Alabama, Choctawhatchee, St. Andrew and Perdido Key beach mice, and Florida salt marsh vole is possible but unlikely. Impact may result from consumption of beach trash and debris. Efforts undertaken for the removal of marine debris or for beach restoration, such as sand replenishment, may temporarily scare away beach mice, destroy their food resources, or collapse the tops of their burrows.

4.2.1.8. Impacts on Coastal and Marine Birds

This section discusses the possible effects of a proposed action in the EPA on coastal and marine birds of the GOM and its contiguous waters and wetlands. Major, potential impact-producing factors for marine birds in the offshore environment include OCS-related helicopter and service-vessel traffic and noise, air emissions, degradation of water quality, habitat degradation, and discarded trash and debris from service-vessels and OCS structures. Any effects are especially grave for intensively managed populations. For example, endangered and threatened species may be harmed by any impact on viable reproductive population size or disturbance of a few key habitat factors.

Proposed Action Analysis

Noise

The transportation or exchange of supplies, materials, and personnel between coastal infrastructure and offshore oil and gas structures is accomplished with helicopters, aircraft, and boats and a variety of service vessels. It is projected that 7,000-9,000 helicopter flights related to a proposed action in the EPA would occur over the life of a proposed action; this is an average rate of 175-225 annual helicopter trips. During the peak year (year 11), 300-400 trips are projected. Service vessels would use selected nearshore and coastal (inland) navigation waterways, or corridors, and adhere to protocol set forth by the USCG for reduced vessel speeds within these inland areas. It is projected that 8,000-9,000 service-vessel trips related to a proposed action in the EPA would occur in the life of a proposed action; this is an average rate of 200-225 service-vessels trips annually. During the peak year (year 11), 300-500 trips are projected.

Major concerns related to helicopter and service-vessel traffic are intense aversion, panic, and head injury following a bird's collision with helicopters or vessels. Birds may also collide with ground structures after being frightened by a near-miss with a helicopter or vessel. Disturbances from OCS-related helicopter or service-vessel traffic to coastal birds can result from the mechanical noise or physical presence (or wake) of the vehicle. The degree of disturbance exhibited by groups of coastal birds to the presence of air or vessel traffic is highly variable, depending upon the bird species in question, type of vehicle, altitude or distance of the vehicle, the frequency of occurrence of the disturbance, and the season. Helicopter and service-vessel traffic related to OCS activities could sporadically disturb feeding, resting, or nesting behavior. Disturbance can also lead to a permanent desertion of active nests or of critical or preferred habitat, which could contribute to the relocation of a species or group to less favorable areas or to a decline of species through reproductive failure resulting from nest abandonment. When birds are flushed prior to or during migration, the energy cost could be great enough that they might not reach their destination on schedule or they may be more susceptible to diseases (Anderson, 1995). Waterfowl are more overtly responsive to noise than other birds and seem particularly responsive to aircraft, possibly because aerial predators frequently harass them (Bowles, 1995). The FAA and corporate helicopter policy advise helicopters to maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms. When flying over land, the specified minimum altitude is 1,000 ft over unpopulated areas or across coastlines and 2,000 ft over populated areas and biologically sensitive areas such as wildlife refuges and national parks. Many undisturbed coastal areas and refuges provide preferred and/or critical habitat for feeding, resting (or staging), and nesting birds. The effect of low-flying aircraft within the vicinity of aggregations of birds on the ground or on the water typically results in mass disturbance and abandonment of the immediate area. However, pilots traditionally have taken great pride in not disturbing birds. Compliance to the specified minimum altitude requirements greatly reduces effects of aircraft disturbance on coastal and marine birds. Routine presence of aircraft at sufficiently high altitudes results in acclimation of birds to routine noise. As a result of inclement weather, about 10 percent of helicopter trips would occur at altitudes somewhat below the minimums listed above. Although these incidents are seconds in duration and sporadic in frequency, they can disrupt coastal bird behavior and, at worst, possibly result in habitat or nest abandonment. Birds in flight over water typically avoid helicopters. Low-flying aircraft may temporarily disrupt feeding or flight paths. Routine presence and low speeds of service vessels within inland and coastal waterways would diminish the effects of disturbance from service vessels on nearshore and inland populations of coastal and marine birds. Birds can lose eggs and young when predators attack nests after parents are flushed into flight by service-vessel noise. Bald eagle nests would be sensitive to overhead noise because they are above the forest canopy, and piping plover nests are on dunes open to the sky. Similarly, bald eagles and brown pelicans feed over open water and piping plover feed on open beaches.

Air Quality Degradation

Contamination of wildlife by air emissions can occur in three ways: inhalation, absorption, and ingestion. Inhalation is the most common mode of contamination for birds (Newman, 1980). The major effects of air pollution include direct mortality, debilitating injury, disease, physiological stress, anemia, hypocalcemica, bioaccumulation of air pollutants with associated decrease in resistance to debilitating factors, and population declines (Newman, 1979). Direct effects can be either acute, such as sudden mortality from hydrogen sulfide, or chronic, such as fluorosis from fluoride emissions. The magnitude of effect, acute or chronic, is a function of the pollutant, its ambient concentration, pathway of exposure, duration of exposure, and the age, sex, reproductive condition, nutritional status, and health of the animal at the time of exposure (Newman, 1980). For metals in air emissions, chemical composition as well as size of particulate compounds has been shown to influence the toxicity levels in animals. Particulate size affects retention time and clearance from and deposition in the respiratory tract (Newman, 1981).

Levels of sulfur oxide (mainly sulfur dioxide, SO_2) emissions from hydrocarbon combustion from OCS-related activities are of concern in relation to birds. Research specific to birds has elucidated both acute and chronic effects from SO_2 inhalation (Fedde and Kuhlmann, 1979; Okuyama et al., 1979). Due to their lack of tracheal submucosal glands, birds appear to have more tolerance for inhaled SO_2 than most mammals (Llacuna et al., 1993; Okuyama et al., 1979). This suggestion stems from laboratory investigations where the test subject was the domestic chicken. Acute exposure of birds to 100 ppm SO_2 produced no alteration in heart rate, blood pressure, lung tidal volume, respiratory frequency, arterial blood gases, or blood pH.

Exposure to 100 ppm or less of SO_2 did not affect respiratory mucous secretion. Exposure to 1,000 ppm SO_2 caused mucus to increase and drip from the mouths of birds, but lungs appeared normal. Exposure to 5,000 ppm resulted in gross pathological changes in airways and lungs, and then death (Fedde and Kuhlmann, 1979). Chronic (two week) exposure of birds to three concentrations of SO_2 for 16 hr/day for various total periods showed a statistical change in 10 cellular characteristics and resulted in cellular changes characteristic of persistent bronchitis in 69 percent of the tests done (Okuyama et al., 1979).

The indirect effects of air emissions on wildlife include food web contamination and habitat degradation, as well as adverse synergistic effects of air emissions combined with natural and other manmade stresses. Air emissions can cause shifts in trophic structure that alter habitat structure and change local food supplies (Newman, 1980).

Air pollutants may cause a change in the distribution of certain bird species (e.g., Newman, 1977; Llacuna et al., 1993). Migratory bird species would avoid potentially suitable habitat in areas of heavy air pollution in favor of cleaner areas if available (Newman, 1979). The abundance and distribution of passerine birds, both active and sedentary, and migratory species, as well as nonpasserine and nonmigratory varieties, are also greatly affected by natural factors such as weather and food supply. Therefore, any reduction in the numbers of birds within a given locale does not have a diagnostic certainty pointing to air emissions (Newman, 1980).

Chapter 4.2.1.1. provides an analysis of the effects of a proposed action on air quality. Emissions of pollutants into the atmosphere from the activities associated with a proposed action would have minimum effects on offshore and onshore air quality because of the prevailing atmospheric conditions, emission heights and rates, and pollutant concentrations. Estimated increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} would be less than 0.29, 0.03, and 0.01 micrograms/m^3, respectively, per modeled steady state concentrations. These concentrations are far below concentrations that could harm coastal and marine birds, including the three listed species (piping plover, bald eagle, and brown pelican).

Water Quality Degradation

Chapter 4.2.1.2. provides an analysis of the effects of a proposed action on water quality. Expected degradation of coastal and estuarine water quality resulting from of OCS-related discharges may affect coastal birds directly by means of acute or chronic toxic effects from ingestion or contact, or indirectly through the contamination of food sources. Operational discharges or runoff in the offshore environment could also affect seabirds (e.g., laughing gulls) that remain and feed in the vicinity of offshore OCS structures and platforms. These impacts could also be both direct and indirect.

Maintenance dredging operations remove several million cubic feet of material, resulting in localized impacts (primarily increased turbidity and resuspended contaminants) during the duration of the operations. Water clarity would decrease over time within navigation channels used for vessel operations and within pipeline canals due to continuous sediment influx from bank erosion, natural widening, and reintroduction of dredged material back into surrounding waters. Turbidity in water may block visual predation on fish by brown pelicans and bald eagles. For a proposed action, the projected, primary service bases are Venice and Fourchon, Louisiana, and Mobile, Alabama; and secondary service bases are Cameron, Intracoastal City, Houma, and Morgan City, Louisiana, and Pascagoula, Mississippi. A proposed action would result in very small incremental contribution to the need for channel maintenance. Coastal and marine birds that feed exclusively within these locations would likely experience chronic, nonfatal physiological stress. Some coastal and marine birds would experience a decrease in viability and reproductive success that would be indistinguishable from natural population variations.

Habitat Degradation

The greatest negative impact to coastal and marine birds is loss or degradation of preferred or critical habitat. The extent of bird displacement resulting from habitat loss is highly variable between different species, based upon specific habitat requirements and availability of similar habitat in the area. Habitat loss interferes especially with the listed birds (brown pelican, piping plover, and bald eagle), which for now require trends of increases in populations rather than stasis and equilibrium. Habitat requirements for most bird species are incompletely known. The analysis of the potential impacts on sensitive coastal environments (**Chapter 4.2.1.3.**) concludes that a proposed action is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in much localized areas downdrift of artificially jettied and maintained channels. Impacts of navigation canals are the most significant OCS-related and proposed-action-related impacts to wetlands.

Coastal and marine birds are susceptible to entanglement in floating, submerged, and beached marine debris; specifically in plastics discarded from both offshore sources and land-derived litter and waste disposal (Heneman and the Center for Environmental Education, 1988). Studies in Florida reported that 80 percent of brown pelicans showed signs of injury from entanglement with fishing gear (Clapp and Buckley, 1984). In addition, seabirds ingest plastic particles and other marine debris more frequently than do any other taxa (Ryan, 1990). Interaction with plastic materials may lead to permanent injuries and death. Ingested debris may have three basic effects on seabirds: irritation and blockage of the digestive tract, impairment of foraging efficiency, and release of toxic chemicals (Ryan, 1990; Sileo et al., 1990a). Effects of plastic ingestion may last a lifetime and may include physical deterioration due to malnutrition; plastics often cause a distention of the stomach, thus preventing its contraction and simulating a sense of satiation (Ryan, 1988). Some birds also feed plastic debris to their young, which could reduce survival rates. The chemical toxicity of some plastics can be high, posing a hazard in addition to obstruction and impaction of the gut (Fry et al., 1987). Sileo et al. (1990b) found that the prevalence of ingested plastic found within the gut of examined birds varied greatly among species. Species that seldom regurgitate indigestible stomach contents are most prone to the aforementioned adverse effects (Ryan, 1990). Within the GOM, these include the phalaropes, petrels, storm petrels, and shearwaters. The piping plover, bald eagle, and the brown pelican would share vulnerability to debris with birds in general. It is expected that coastal and marine birds would seldom become entangled in or ingest OCS-related trash and debris as a result of MMS prohibitions on the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which prohibits the disposal of any plastics, garbage, and other solid wastes at sea or in coastal waters, went into effect January 1, 1989, and is enforced by the USCG.

Summary and Conclusion

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

Bald eagle, piping plover, and brown pelican use habitat that is open to the sky, thus impacted by helicopter noise. They would also be susceptible to disturbance by discarded debris. Turbidity may hide pelagic fishes from predation by brown pelican.

4.2.1.9. Impacts on Endangered and Threatened Fish

4.2.1.9.1. Gulf Sturgeon

Effects on Gulf sturgeon from routine activities associated with a proposed action could result from degradation of estuarine and marine water quality, pipeline installation, and drilling and produced water discharges. Potential impacts from accidental oil spills on Gulf sturgeon are discussed in **Chapter 4.4.9.1.**

Proposed Action Analysis

Drilling mud discharges may contain chemicals that are toxic to Gulf sturgeon at concentrations four of five orders of magnitude higher than concentrations found a few meters from the discharge point. Offshore discharges of drilling muds are expected to dilute to background levels within 1,000 m of the discharge point.

Produced-water discharges may contain components potentially detrimental to Gulf sturgeon. Moderate heavy-metal and hydrocarbon contamination of sediments and the water column are expected to occur out to several hundred meters downcurrent from the discharge point (CSA, 1997b); however, offshore discharges of produced water are expected to disperse and dilute to background levels within 1,000 m of the discharge point.

All of the proposed 50-800 km of pipelines would be laid in deep water. Regulations do not require burial of pipelines in >60 m water depth; therefore, little resuspension of sediments would result. Gulf sturgeons are expected to avoid lay-barge equipment and resuspended sediments. No impacts on Gulf sturgeon are expected from installation of the projected pipelines.

Minor degradation of estuarine water quality is expected in the immediate vicinity of shorebases and other OCS-related facilities as a result of routine effluent discharges and runoff. Only a small amount of the routine dredging done in coastal areas would be directly or indirectly due to a proposed action.

Platform removal may kill some Gulf sturgeon, but the fish is not typically drawn to underwater structures.

Summary and Conclusion

Potential impacts on Gulf sturgeon may occur from resuspended sediments and OCS-related discharges, as well from nonpoint runoff from estuarine OCS-related facilities. The low toxicity of this pollution and the unlikely, simultaneous occurrence of individual Gulf sturgeon and of contamination is expected to result in little impact of a proposed action on Gulf sturgeon. Routine activities resulting from a proposed action in the EPA are expected to have little potential effects on Gulf sturgeon.

4.2.1.9.2. Smalltooth Sawfish

Effects on smalltooth sawfish from routine activities associated with a proposed action could potentially result from jetsam and flotsam resulting from exploration and development activities and associated vessel traffic, pipeline installation, drilling and produced-water discharges, and structure-removal operations. Potential impacts from accidental oil spills on smalltooth sawfish are discussed in **Chapter 4.4.9.2.**

Proposed Action Analysis

Fishing and habitat alteration and degradation in the past century have reduced the U.S. population of the smalltooth sawfish (USDOC, NMFS, 2000). At present, the smalltooth sawfish is primarily found in southern Florida in the Everglades and Florida Keys. Historically, this species was common in neritic and coastal waters of Texas and Louisiana. Many records of the smalltooth sawfish were documented in the 1950's and 1960's from the northwestern Gulf in Texas, Louisiana, Mississippi, and Alabama. Since 1971, however, there have been only three published or museum reports of the species captured in the region, all from Texas (1978, 1979, and 1984). Additionally, reports of captures have dropped dramatically. Louisiana, an area of historical localized abundance, has experienced marked declines in sawfish landings. The lack of smalltooth sawfish records since 1984 from the area west of peninsular Florida is a clear indication of their rarity in the northwestern Gulf.

Drilling mud discharges may contain chemicals that would be toxic to smalltooth sawfish. Offshore discharges of drilling muds are expected to dilute to background levels within 1,000 m of the discharge point. Produced-water discharges may contain components potentially detrimental to smalltooth sawfish. Moderate heavy-metal and hydrocarbon contamination of sediments and the water column are expected to occur out to several hundred meters downcurrent from the discharge point (CSA, 1997b); however, offshore discharges of produced water are expected to disperse and dilute to background levels within 1,000 m of the discharge point.

All of the proposed 50-800 km of pipelines would be laid in deep water. Smalltooth sawfish typically inhabit infralittoral waters (<100 m in depth) and would not be impacted by any proposed pipelines in deep water as a result of a proposed action.

Minor degradation of estuarine water quality is expected in the immediate vicinity of shore bases and other OCS-related facilities as a result of routine effluent discharges and runoff, and a small amount of the routine dredging may occur in coastal areas due to a proposed action. However, the shore bases projected to be used in support of a proposed action and the potential dredging activities are located in areas where smalltooth sawfish are no longer likely to occur.

Summary and Conclusion

Potential impacts to smalltooth sawfish may occur from jetsam and flotsam, suspended sediments, OCS-related discharges, and nonpoint runoff from estuarine, OCS-related facilities. However, because the current population of smalltooth sawfish is primarily found in southern Florida in the Everglades and Florida Keys, impacts to these rare animals from routine activities associated with a proposed action are expected to be miniscule.

4.2.1.10. Impacts on Fish Resources and Essential Fish Habitat

Effects on fish resources and EFH from activities associated with a proposed action could result from coastal environmental degradation, marine environmental degradation, petroleum spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters. Potential effects from routine activities resulting from a proposed action on fish resources and EFH are described below. Potential effects on the two habitats of particular concern for GOM fish resources (Weeks Bay National Estuarine Research Reserve in Alabama and Grand Bay in Mississippi and Alabama) are included under the analyses for wetlands (**Chapter 4.2.1.3.2.**). Potential effects from accidental events (blowouts and spills) on fish resources and EFH are described in **Chapter 4.4.10.** Potential effects on commercial fishing from a proposed action are described in **Chapter 4.2.1.11.**

Healthy fish resources and fishery stocks depend on EFH waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Because of the wide variation of habitat requirements for all life history stages (as described in **Chapter 3.2.8.**, Fisheries) for managed fish species, the EFH for the GOM includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the EEZ. Collectively, the adverse impacts on coastal EFH and marine EFH are called, respectively, coastal and marine environmental degradation in this analysis.

Few fish species within the proposed lease sale area are estuary dependent, although indirect associations of fish species with those that are estuary dependent can be assumed (Darnell and Soniat, 1979; Darnell, 1988), particularly if artificial reef species are considered. Coastal environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and fish resources. The environmental deterioration and effects on EFH and fish resources result from the loss of GOM wetlands and coastal estuaries as nursery habitat and from the functional impairment of existing habitat through decreased water quality (Chambers, 1992; Stroud, 1992).

Wetlands and estuaries within Louisiana, Mississippi, and Alabama may be affected by activities resulting from a proposed action (**Chapters 4.2.1.3.2. and 4.4.3.2.**). These activities include expansion of onshore facilities in wetland areas, vessel usage of navigation channels and access canals, maintenance of navigation channels, inshore disposal of OCS-generated petroleum-field wastes, and spills from both coastal and offshore OCS-support activities.

Coastal water quality (**Chapters 4.2.1.2.1. and 4.4.2.1.**) may be adversely affected by saltwater intrusion and sediment disturbances from channel maintenance dredging, onshore pipeline emplacements, and canal widening. Trash, discharges, runoff, and spills may be released from onshore facilities and vessel traffic and cause degradation of coastal water quality. Besides coastal sources, offshore spills and trash occurring in association with OCS operations and reaching coastal waters may impact water quality conditions.

Since all of the fish species within a proposed lease sale area are dependent on offshore water, marine environmental degradation resulting from a proposed action has the potential to adversely affect EFH and fish resources. In general, offshore EFH includes both high- and low-relief live bottoms (pinnacles) and both natural (topographic features) and artificial reefs. There are no natural banks or pinnacles in the proposed lease sale area (in the traditional sense as found on the continental shelf). A proposed action could impact soft-bottom communities, hard-bottom communities (although rare in deep-water) organisms colonizing scattered anthropogenic debris and artificial reefs. Impact-producing factors that could affect EFH include infrastructure emplacement, anchoring, infrastructure removal, operational offshore waste discharges, blowouts, and to a limited extent, laying of pipelines. The impacts could include immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible.

The attraction of pelagic highly migratory fish species to artificial structures in deepwater areas of the GOM is an evolving issue. The existing information on fish attracting devices (FAD) indicates that several commercially and recreationally important species would be or are already being attracted to GOM offshore structures. The main species are yellowfin tuna (*Thunnus albacares*), skipjack (*Katsuwonus pelamis*), and bigeye tuna (*Thunnus obesus*). There are a number of possible ramifications that may include primary ecological effects including: (1) changes in distribution patterns (particularly due to aggregation and concentration), (b) changes in movement and migration patterns; (c) changes in spawning and larval survival/recruitment (due to a and b above). A number of possible secondary, indirect effects of FAD's include (1) increased catchability and fishing mortality due to aggregation around structures, and (2) changes in population age structure due to increased or changed age-specific mortality due to fishing. At this point in time, it is not known to what extent deepwater structures are acting as FAD's. A study performed by USGS/BRD to assess existing literature and synthesize information from a special FAD's workshop has recently been completed. Discussion of these results and directions for potential future studies are ongoing. The present literature does not include substantive data for the GOM; however, the results of this USGS/BRD project is leading to new studies that will directly address GOM highly migratory species and their attraction to deepwater platforms.

Impact-producing factors from routine offshore activities that could result in marine water quality degradation include platform and pipeline installation, platform removal, and the discharge of operational wastes (**Chapter 4.2.1.2.2.**). Offshore accidents including blowouts and spills from platforms, service vessels, and pipelines could also occur and potentially alter offshore water quality (**Chapter 4.4.2.2.**). Coastal operations could indirectly affect marine water quality; offshore water quality can be impacted through migration of contaminated coastal waters (**Chapter 4.2.1.2.1.**).

Chronic, low-level pollution is a persistent and recurring event resulting in frequent but nonfatal physiological irritation to those resources that lie within the range of impact and that are likely to be adversely affected by the pollution. The geographic range of the pollutant effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource to the pollutant in question (in this case hydrocarbons).

Drilling muds contain materials, such as lead and cadmium, that in high concentrations are toxic to fishery resources; however, the discharge plume disperses rapidly, is very near background levels at a distance of 1,000 m, and is usually undetectable at distances greater than 3,000 m (Kennicutt, 1995) (**Chapter 4.1.1.4.1.**, Drilling Muds and Cuttings). Since 1993, USEPA has required concentrations of mercury and cadmium to be less than or equal to 1 ppm and 3 ppm, respectively, in the stock barite used to make drilling muds. There has recently been increased media focus on mercury uptake in fish and other marine species. An MMS-funded study titled *Gulf of Mexico Offshore Operations Monitoring Experiment* (Kennicutt, 1995) analyzed sediments at three sites in the GOM. Results of this study indicated that mercury levels were slightly elevated in sediments or organisms at one platform site (High Island Block A-389). The average concentration of mercury at High Island Block A-389 was twice as high as the other two platforms. The highest average concentration (0.41 µg/g) was found within 50 m of the platform, but decreased to 0.12 µg/g at 100 m. Although these concentrations were the highest found, they were low relative to the probable effects level (0.7) believed to cause biological effects. This platform used the practice of shunting drilling muds and cuttings to within 10 m of the seafloor to avoid dispersal and prevent impact to the nearby East Flower Garden Bank. Shunting will not occur in the proposed action area.

In this same study, metal concentrations were measured in tissues for 37 marine species. Fish tissue concentrations were generally low; for example, the average concentration was 0.45 µg/g for all flounder species, 0.39 µg/g for all hake species, and 0.24 µg/g for all snapper species. Shrimp had statistically higher tissue concentrations (0.36 µg/g) near platforms than far from platforms (0.19 µg/g). These values are well below the Federal guidelines set by FDA to protect human health, which is 1 ppm. Additional discussion of mercury in drilling muds can be found in **Chapter 4.1.1.4.1.**

In addition to toxic trace elements and hydrocarbons in produced waters, there are additional components and properties, such as hypersalinity and organic acids, that have a potential to adversely affect fishery resources. Produced waters that are discharged offshore are diluted and dispersed to very near background levels at a distance of 1,000 m and are undetectable at a distance of 3,000 m from the discharge point (Harper, 1986; Rabalais et al., 1991; Kennicutt, 1995).

Proposed Action Analysis

The effects of a proposed action on coastal wetlands and coastal water quality, with the exception of accidental events, are analyzed in detail in **Chapters 4.2.1.3.2. and 4.2.1.2.1.**, respectively. Collectively, the adverse impacts from these effects are called coastal environmental degradation in this EIS. The effects of a proposed action on marine water quality are analyzed in detail in **Chapter 4.2.1.2.2.** Collectively, the adverse impacts from these effects are called marine environmental degradation in this EIS. The direct and/or indirect effects from coastal and marine environmental degradation on fish resources and EFH are summarized and considered below.

Coastal Environmental Degradation

A proposed action is projected to increase traffic in navigation channels to and from service bases from Louisiana to Alabama. This may result in some erosion of wetlands along the channels, particularly in Louisiana. Little erosion along the navigation channels in Mississippi and Alabama is expected because the channels are in upland areas and the banks are developed. Additional information regarding erosion along navigation channels is provided in the wetland analysis (**Chapter 4.2.1.3.2.**).

No new pipeline landfalls are projected in support of a proposed action. A total of four new pipelines are projected but these are projected to connect to existing or proposed pipelines that extend into deep water.

Localized, minor degradation of coastal water quality is expected in waterbodies in the immediate vicinity of coastal shore bases, commercial waste-disposal facilities, and oil refineries or gas processing plants as a result of routine effluent discharges and runoff. A proposed action in a proposed action area is projected to contribute a small percentage of the OCS-Program-related use of these facilities.

Maintenance dredging of waterways and channels would result in decreased water clarity and some resuspension of contaminants. This could preclude, in rare instances, uses of those waters directly affected by the dredging operations for up to several months. The periods between projected dredging operations, ranging from 1-2 years, should generally allow for the recovery of affected areas. Only a very small amount of the routine dredging done in coastal areas would be directly or indirectly due to a proposed action.

It is expected that coastal environmental degradation from a proposed action would have little effect on fish resources or EFH. Wetlands that could be impacted for some period of time or converted to open water are discussed in the wetlands analysis (Chapter 4.2.1.3.2.). Recovery of fish resources or EFH can occur from more than 99 percent, but not all, of the potential coastal environmental degradation. Fish populations, if left undisturbed, would regenerate in one generation and most EFH can recuperate quickly, but the loss of wetlands as EFH could be permanent. At the expected level of effect, the resultant influence on fish resources or EFH from a proposed action would be negligible and indistinguishable from natural population variations.

Marine Environmental Degradation

For any activities associated with a proposed action, USEPA's Region 4 would regulate discharge requirements through their NPDES permits. Contaminant levels in the EPA are generally low, reflecting the lack of pollution sources and high-energy environment of much of the region. The primary water quality impact from any increased turbidity would be localized decreased water clarity. Bottom disturbance from emplacement operations associated with a proposed action would produce localized, temporary increases in suspended sediment loading, resulting in decreased water clarity and little reintroduction of pollutants.

The major sources of discharges associated with a proposed action to marine waters are the temporary discharge of drilling muds and cuttings and the long-term discharge of produced-water effluent. Both of these discharges contain various contaminants of concern (e.g., trace metals and petroleum-based organic) that may have environmental consequences on marine water quality and aquatic life. Drilling mud discharges contain chemicals toxic to marine fishes; however, this is only at concentrations four or five orders of magnitude higher than the concentrations found a few meters from the discharge point. Offshore discharges of drilling muds are expected to dilute to background levels within 1,000 m of the discharge point.

Produced-water discharges contain components and properties potentially detrimental to fish resources. Moderate petroleum and metal contamination of sediments and the water column are expected to occur out to several hundred meters downcurrent from the discharge point (CSA, 1997a). However, these results would be expected to be far less at the greater water depths of a proposed action (1,600-3,000 m). Offshore discharges of produced water are expected to disperse and dilute to background levels within 1,000 m of the discharge point.

The projected total number of platform installations resulting from a proposed action is only two structures for all water depths. Ten years after a platform is installed, the structure would be acting as a climax community artificial reef. Essentially 100 percent of the platform-associated species present would represent new biomass and not recruits from nearby live bottoms due to the extreme distances and water depths separating them. All structures associated with a proposed action are expected to be removed 36 years after the lease sale. Structure removal results in at least some loss of artificial-reef habitat. It is expected that structure removals would have a negligible effect on fish resources because of their low numbers and the fact that the principal managed fishery resource associated with the structures (highly migratory species) are not dependent on specific structures for survival. Tropical species associated with the upper structure that would be removed or relocated would probably perish due to their introduction to a pelagic environment that would not provide food resources or habitat critical for their survival.

The projected length of pipeline installations for a proposed action is 50-800 km. With connection to existing pipelines in deep water, there would be no trenching for pipeline burial, which has the potential to adversely affect fish resources. Without burial, the resultant influence on fish resources would be negligible and indistinguishable from other natural population variations. Exposed pipeline in deep water would also act as hard substrate and have a positive impact on many deep-water fish species.

It is expected that marine environmental degradation from a proposed action would have little effect on fish resources or EFH. The impact of marine environmental degradation is expected to cause an undetectable decrease in fish populations. Recovery of fish resources or EFH can occur from 100 percent of the potential marine environmental degradation. Fish populations, if left undisturbed, would regenerate in one generation. The USEPA NPDES permits would regulate offshore discharges and subsequent changes to marine water quality. At the expected level of effect, the resultant influence on fish resources or EFH would be negligible and indistinguishable from natural population variations.

Summary and Conclusion

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

The USEPA NPDES permits would regulate offshore discharges and subsequent changes to marine water quality. At the expected level of impact, the resultant influence on fish resources and EFH would be negligible and indistinguishable from natural population variations.

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

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

4.2.1.11. Impacts on Commercial Fishing

Effects on commercial fishing from activities associated with a proposed action could result from installation of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, subsurface blowouts, and petroleum spills. Potential effects from routine activities resulting from a proposed action in a proposed action area on fish resources and EFH are described in **Chapter 4.2.1.10.** Potential effects from accidental events (spills and blowouts) on fish and EFH are described in **Chapter 4.4.10.** Potential effects on commercial fishing from routine activities resulting from a proposed action are described below.

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 managed species in the CPA, the EFH for the GOM includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the EEZ. Collectively, the adverse impacts on coastal EFH and marine EFH are called, respectively, coastal and marine environmental degradation in this analysis.

Few fish species within a proposed action area are estuary dependent, although indirect associations of fish species with those that are estuary dependent can be assumed (Darnell and Soniat, 1979; Darnell, 1988), particularly if artificial reef species are considered. Coastal environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and commercial fisheries. Environmental deterioration and effects on EFH and commercial fisheries result from the loss of GOM wetlands and coastal estuaries as nursery habitat and from the functional impairment of existing habitat through decreased water quality (Chambers, 1992; Stroud, 1992).

Wetlands and estuaries within Louisiana, Mississippi, and Alabama may be affected by activities resulting from a proposed action (**Chapters 4.2.1.3.2. and 4.4.3.2.**). These activities include construction or expansion of onshore facilities in wetland areas, vessel usage of navigation channels and access canals, maintenance of navigation channels, inshore disposal of OCS-generated petroleum-field wastes, and spills from both coastal and offshore OCS-support activities.

Coastal water quality (**Chapters 4.2.1.2.1. and 4.4.2.1.**) may be adversely affected by saltwater intrusion and sediment disturbances from channel maintenance dredging, onshore pipeline emplacements, and canal widening. Trash, discharges, runoff, and spills may be released from onshore facilities and vessel traffic and cause degradation of coastal water quality. Besides coastal sources, offshore spills and trash occurring in association with OCS operations and reaching coastal waters may impact water quality conditions.

Since all of the fish species harvested within a proposed action area are dependent on offshore water, marine environmental degradation resulting from a proposed action has the potential to adversely affect EFH and fish resources. In general, offshore EFH includes both high- and low-relief live bottoms (pinnacles) and both natural (topographic features) and artificial reefs; however, there are no natural banks or pinnacles in a proposed action area (in the traditional sense as found in the photic zone on the continental shelf). A proposed action could impact soft-bottom communities, hard-bottom communities (those that could exist in deep water), and organisms colonizing scattered anthropogenic debris and artificial reefs; however, there are no commercially important bottom species in the proposed lease sale area. Impact-producing factors that could affect EFH include infrastructure emplacement, anchoring, infrastructure removal, operational offshore waste discharges, blowouts, and pipeline trenching.

Impact-producing factors from routine offshore activities that could result in degradation of marine water quality include platform and pipeline installation, platform removal, and the discharge of operational wastes (**Chapter 4.2.1.2.2.**). Offshore accidents including blowouts and spills from platforms, service vessels, and pipelines could also occur and potentially alter marine water quality (**Chapter 4.4.2.2.**). Coastal operations could indirectly affect marine water quality; offshore water quality can be impacted through migration of contaminated coastal waters (**Chapter 4.4.2.1.**).

The area occupied by structures, anchor cables, and safety zones (for vessels larger than 100 feet) associated with a proposed action would be unavailable to commercial fishermen and could cause space-use conflicts. Exploratory drilling rigs would spend approximately 30-150 days onsite and would cause short-lived interference to commercial fishing. A floating production system in deeper water requires as much as 5 ha of space. The use of FPSO's is not projected for a proposed action, and the USCG has not yet determined what size of a navigational safety zone would be required for an FPSO during normal or offloading operations.

Underwater OCS obstructions, such as pipelines, can cause gear conflicts that result in losses of trawls and catch, business downtime, and vessel damage. Water depths in a proposed action area are generally deeper than any commercial trawling activities (>1,600 m). Virtually all commercial trawl fishing in the GOM is performed in water depths less than 200 m (Louisiana Dept. of Wildlife and Fisheries, 1992). Longline fishing is performed in water depths greater than 100 m and usually beyond 300 m; however, all longline fishing is prohibited in two areas in the vicinity of DeSoto Canyon. One of these areas includes an area north of 28 degrees latitude (described in **Chapter 3.3.1.**, Commercial Fishing) that encompasses 160 potential lease blocks from the total of 256 in a proposed action area. Although GOM fishermen are experiencing some economic loss from gear conflicts, the economic loss for a fiscal year has historically been less than 0.1 percent of the value of that same fiscal year's commercial fisheries landings. In addition, most financial losses from gear conflicts are covered by the Fishermen's Contingency Fund (FCF).

Lessees are required to remove all structures and underwater obstructions from their leases in the Federal OCS within one year of the lease relinquishment or termination of production (**Chapter 4.1.1.11.**, Decommissioning and Removal Operations).

Chronic, low-level pollution is a persistent and recurring event, resulting in frequent but nonfatal physiological irritation to those resources that lie within the range of impact and that are likely to be adversely affected by the pollution. The geographic range of the pollutant effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource to the pollutant in question (in this case hydrocarbons).

Drilling muds contain materials, such as lead and cadmium, that in high concentrations are toxic to fishery resources; however, the plume disperses rapidly, is very near background levels at a distance of 1,000 m, and is usually undetectable at distances greater than 3,000 m (Kennicutt, 1995) (**Chapter 4.1.1.4.1.**, Drilling Muds and Cuttings). Since 1993, USEPA has required concentrations of mercury and cadmium to be less than or equal to 1 ppm and 3 ppm, respectively, in the stock barite used to make drilling muds. Trace amounts of mercury that are naturally occurring in the major drilling mud component barite has been raised as an issue by the media. Mercury in drilling mud is described in more detail in **Chapters 3.1.2., 4.1.1.4.1., and 4.2.1.10.** Although mercury that is found in the tissues of some large size predatory fish is a concern, there is no current evidence that contributions from drilling discharges play any major role.

In addition to toxic trace elements and hydrocarbons in produced waters, there are additional components and properties, such as hypersalinity and organic acids, that have a potential to adversely affect commercial fishery resources. Produced waters that are discharged offshore are diluted and dispersed to very near background levels at a distance of 1,000 m and are undetectable at a distance of 3,000 m from the discharge point (Harper, 1986; Rabalais et al., 1991; Kennicutt, 1995).

Proposed Action Analysis

Installation of offshore structures may cause space-use conflicts with commercial fishing activities. Only two production structure installations are projected for a proposed action. Using the 500-m navigational safety zone figure (although to date only seven operators throughout the GOM have established an official safety zone and six other operators have initiated the process for obtaining the USCG safety zone around production platforms), the possible area excluded from commercial trawl fishing or longlining would be approximately 95 ha, depending on the size of the facility itself. Technically, the safety zone exclusion would not apply to vessels smaller than 100 ft. The maximum excluded area of 190 ha (2 structures @ up to 95 ha each including safety zones) represents only a very small fraction (0.0003%) of the total area of a proposed action. There is no use of FPSO's projected for a proposed action. All structures associated with a proposed action are projected to be removed by the year 2037.

Two large areas in the DeSoto Canyon Area have been designated by NOAA Fisheries as swordfish nursery areas and are closed to longline fishing activities. The boundaries of the closed areas are described in **Chapter 3.3.1.**, Commercial Fishing, and are shown on **Figure 3-9**. The longline closure areas are located largely in the EPA. One of these includes an area north of 28 degrees latitude that encompasses 160 potential lease blocks from the total of 256 in a proposed action area. A small portion of the northern closed area includes 174 blocks in the CPA in the Mississippi Canyon, Main Pass, Viosca Knoll, and Mobile lease areas. The closed areas cover nearly 845,000 km^2 and would displace commercial longlining, which may increase activity in the CPA and possibly the WPA. Longline fishing could occur in the 96 blocks of a proposed action south of 28 degrees latitude, but some portion of these blocks bordering the closed area would also be avoided due to the extreme length of longline sets and time required for their retrieval.

Underwater OCS obstructions such as pipelines could cause fishing gear loss and additional user conflicts but none of a proposed action area occurs in water depths shallower than 1,600 m. Gear loss and user conflicts are mitigated by the FCF. Direct payments for claims in FY 1997 totaled $238,404 and total payments for FY 1998 were $311,290. The amount available for GOM FCF claims in FY 1999 was $1,212,969. The majority of claims are resolved within six months of filing. The economic loss from gear loss and user conflicts has historically been less than 0.1 percent of the same year's value of GOM commercial fisheries landings. It is expected that installed pipelines in the proposed lease sale area should never conflict with bottom trawl or other fishing activities other than during temporary exclusion from the area of a pipelaying barge, and they are expected to have a negligible effect on commercial fishing.

Structure emplacements can act as FAD's and can result in aggregation of highly migratory fish species. A number of commercially important highly migratory species, such as tunas and marlins, are known to congregate and be caught around FAD's. Structure removals result in loss of artificial-reef habitat. It is expected that structure removals would have a negligible effect on commercial fishing because of the inconsequential number of removals (maximum of 2) and the consideration that removals kill only those fish proximate to the removal site.

Seismic surveys would occur in a proposed action area. Usually, fishermen are precluded from a very small area for several days. This should not impact the annual landings or value of landings for commercial fisheries in the GOM. The GOM species can be found in many adjacent locations and GOM commercial fishermen do not fish in one locale. Gear conflicts between seismic surveys and commercial fishing are also mitigated (see above) by the FCF. All seismic survey locations and schedules are published in the USCG *Local Notice to Mariners,* a free publication available to all fishermen. Seismic surveys would have a negligible effect on commercial fishing.

Summary and Conclusion

Activities such as seismic surveys would cause negligible impacts and would not deleteriously affect commercial fishing activities. Operations such as production platform emplacement, and underwater OCS impediments, would cause slightly greater impacts on commercial fishing. Some positive impacts to commercial fishing resulting from fish aggregating around deepwater structures may be possible. At the expected level of impact, the resultant influence on commercial fishing would be indistinguishable from variations due to natural causes. As a result, there would be very little impact to commercial fishing. A proposed action is expected to result in less than a 1 percent change in activities, in pounds landed, or in the value of landings. It would require less than six months for fishing activity to recover from any impacts.

4.2.1.12. Impacts on Recreational Fishing

This section discusses the possible effects of a proposed action on recreational fishing. Impact-producing factors associated with a proposed lease sale that could directly impact recreational fishing in the offshore environment include the presence of offshore structures, pipeline installation activities, and spills. Potential effects from accidental events including spills on recreational fishing are described in **Chapter 4.4.11.**

Recreational fishing could be indirectly impacted by adverse effects of a proposed action on fish stocks or EFH. The analyses of the potential impacts of a proposed action on fish resources and EFH (**Chapter 4.2.1.10.**) and on commercial fisheries (**Chapter 4.2.1.11.**), especially in regard to fish populations, also applies to recreational fishing.

As indicated in **Chapter 3.3.2.**, marine recreational fishing along Florida's west coast, and coastal Alabama, Mississippi, and Louisiana is very popular with both residents and tourists, and is economically important to coastal states. The latest information from the NMFS Marine Recreational Fisheries Statistics Survey (USDOC, NMFS, 2002) indicates there were almost 2 million resident participants in GOM saltwater fishing from Louisiana to Florida and a similar number of out-of-state (tourist) fishermen. Of these resident and tourist fishermen from Louisiana to Florida, an estimated 1.9 million offshore fishing trips occurred in Federal waters (>10 mi off Florida's west coast and >3 mi off Alabama, Louisiana, and Mississippi) during 2001 (USDOC, NMFS, 2002). The greatest number of fish caught and landed from this offshore zone included dolphins, grunts, jacks, porgies, groupers, snappers, and mackerels. Likewise, a significant amount of effort is expended by a specialized group of big game or billfish fishermen seeking primarily tuna, marlin, and wahoo focused in deep offshore waters from south of the Mississippi Delta to the DeSoto Canyon off northwest Florida.

Figure 1-1 depicts the proposed lease sale area in relation to the coastline from Louisiana to western Florida. Because of the great distances to all of the identified lease tracts offered for consideration in a proposed action, only fishermen departing from northwest Florida to coastal Alabama are likely to be impacted by a proposed action. Almost all offshore recreational fishing is currently confined within 100 mi of shore and most of a proposed action area lies about 100 mi from the Mississippi, Alabama, and Florida shores. The Louisiana Mississippi River delta coastline lies 70 mi from the proposed lease sale area, but no major recreational fishing ports are located in the area. Very few fishing trips go beyond the 200-m contour line, the DeSoto Canyon area, or 100 mi from shore.

Proposed Action Analysis

Although it is evident from available information that offshore recreational fishing is a popular, productive, and economically significant activity in the offshore waters of the northeastern GOM, no definitive information exists on the level and precise location of recreational fishing in the 256 tracts included in the proposed lease sale area. Beyond the 900-m bathymetric contour, very little recreational fishing is believed to occur because of the water depth, the distance from shore, and the lack of known natural features or artificial reefs, all of which make recreational fishing impractical, very costly, and unproductive. The proposed lease sale area is 138 nmi from Panama City, Florida; 100 nmi from Pensacola, Florida; and 123 nmi from Biloxi, Mississippi.

The type of development activities most likely to affect fish and recreational fishing within a proposed lease sale area most frequented by offshore fishermen is the introduction of high-profile structures, specifically drilling rigs and platforms. Rigs and platforms function as very large *de facto* artificial reefs. They attract and concentrate sport fish and stimulate the growth of marine life, which, in turn, attract fishermen and divers (Bull et al., 1997). Many studies (Ditton and Auyong, 1984; Roberts and Thompson, 1983; Ditton and Graefe, 1978; Dugas et al., 1979) have demonstrated that, when GOM petroleum structures are accessible to marine recreational fishermen and scuba divers, the structures are a major attraction throughout their entire lifetime for marine recreational fishing and are a positive influence on tourism and coastal economics. The introduction of two production facilities as a result of a proposed action could attract recreational fishermen to pursue game fish attracted to these deepwater structures. It is unlikely that recreational divers would venture as far as any structures in the proposed lease sale area for diving or spearfishing. Even if production facilities applied for and established 500-m safety zones, this would not exclude any recreational fishing vessel less than 100 ft in length. Fishing prospects are likely to improve by those choosing to fish in the immediate vicinity of rigs and platforms.

Oil and gas development and production resulting from this proposal would require the installation of pipelines to gather and transport petroleum products to onshore processing and refining facilities. No interaction between offshore pipelines and recreational fishing is likely after construction is complete due to the extreme water depths and no attempted fishing on the bottom. Short-term, space-use conflict could occur during the time that any pipeline is being installed.

Summary and Conclusion

The leasing, exploration, development, production, and transportation of oil and gas in the proposed lease sale area could attract limited additional recreational fishing activity to petroleum structures installed on productive leases. Each structure placed in the GOM to produce oil or gas would function as a *de facto* artificial reef, attract sport fish, and improve fishing prospects in the immediate vicinity of platforms. This impact would last for the life of the structure, until the structures are removed from the location and the marine environment. A proposed action would have a beneficial effect on offshore and deep-sea recreational fishing within developed leases accessible to fishermen. The 100-mi travel distance would be substantial but not insurmountable. These effects would last until the production structures are removed from the marine environment. Short-term space-use conflict could occur during the time that any pipeline is being installed.

4.2.1.13. Impacts on Recreational Resources

This section discusses the possible effects of a proposed action on GOM recreational beaches. Millions of annual visitors attracted to these resources are responsible for thousands of local jobs and billions of dollars in regional economic activity. Major recreational beaches are defined as those frequently visited sandy areas along the shoreline that are exposed to the GOM and that support a multiplicity of recreational activities, most of which is focused at the land and water interface. Included are Gulf Islands National Seashore, State parks and recreational areas, county and local parks, urban beaches, private resort areas, and State and private environmental preservation and conservation areas. The general locations of these beaches are indicated on MMS Visual 2—Multiple Use (USDOI, MMS, 2001c).

The primary impact-producing factors to the enjoyment and use of recreational beaches are trash and debris, and oil spills. Additional factors such as the physical presence of platforms and drilling rigs can affect the aesthetics of beach appreciation, and noise from OCS-related aircraft can adversely affect a beach-related recreation experience. All these factors, either individually or collectively, may adversely affect the number and value of recreational beach visits. The potential impacts from oil spills and other accidental events on recreational resources are discussed in **Chapter 4.4.**

The value of recreation and tourism in the GOM coastal zone from Texas through Florida has been estimated in the tens of billions of dollars annually (USDOI, MMS, 2001e; pages III-101 and III-102). A significant portion of these expenditures is made in coastal counties, where major shoreline beaches are primary recreational attractions. Over one million people visit the mainland unit and barrier island beaches of the Gulf Island National Seashore in Mississippi and Florida annually, demonstrating the popularity of destination beach parks throughout the Gulf Coast region east of the Mississippi River. Trash and debris from OCS operations can wash ashore on GOM recreational beaches. Litter on recreational beaches from OCS operations could adversely affect the ambience of the beach environment, detract from the enjoyment of beach activities, and increase administrative costs on maintained beaches. Some trash items, such as glass, pieces of steel, and drums with chemical residues, can also be a health threat to users of recreational beaches. Current industry waste management practices; training and awareness programs focused on the beach litter problem; and the OCS industry's continuing efforts to minimize, track, and control offshore wastes are expected to minimize potential for accidental loss of solid wastes from OCS oil and gas operations.

Since the proposed lease sale area is so far from shore (70 mi from Louisiana, 98 mi from Mississippi, 93 mi from Alabama, and 100 mi from Florida), platforms and drilling rigs would not be visible from shore. However, noise associated with vessels and aircraft traveling between coastal service bases and offshore operation sites can adversely affect the natural ambience of coastal beaches. Although this may affect the quality of recreational experiences, it is unlikely to reduce the number of recreational visits to coastal beaches in the GOM.

Proposed Action Analysis

A proposed action is projected to result in the drilling of 30-40 exploration and development wells and the installation of 2 platforms. Marine debris would be lost from time to time from these operations. Waste management practices and training programs are expected to minimize the level of accidental loss of solid wastes from activities resulting from a proposed action. Since Louisiana is closest to the proposed lease sale area, it would be the most likely state to be affected by any waterborne trash. Beached litter and debris from a proposed action are likely to be imperceptible to beach users or administrators; a lease sale and its subsequent activity constitutes only a small percentage of the total OCS Program. Between 8,000 and 9,000 service-vessel trips are estimated to occur over the life of a proposed action or about 200-225 trips annually. The estimated number of helicopter trips is 7,000-9,000, which is approximately 175-225 trips annually. Vessels and helicopters are expected to use service bases in or around the ports of Venice and Fourchon, Louisiana, and Mobile, Alabama. Vessels are assumed to use established nearshore traffic lanes and helicopters are assumed to comply with aerial clearance restrictions at least 90 percent of the time. This additional helicopter and vessel traffic would add little noise pollution as long as it is disbursed over a range of times and places.

Summary and Conclusion

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

4.2.1.14. Impacts on Archaeological Resources

This section discusses potential impacts from a proposed action. Major impact-producing factors that could affect both prehistoric and historic archaeological resources are direct physical contact from drilling rig and platform emplacement; pipeline installation and trenching; anchoring; dredging activity; oil spills; and ferromagnetic debris. Chapters of this EIS that provide supportive material for the archaeological resources analysis include **Chapters 3.3.4.** (Archaeological Resources), **4.1.1.** (Offshore Impact-Producing Factors and Scenario), **4.1.2.1.** (Coastal Infrastructure), and **4.3.1**. (Oil Spills).

Blocks with a high probability for the occurrence of prehistoric, prehistoric and historic, or historic archaeological resources are found in the EPA. Blocks with a high probability for prehistoric archaeological resources are found landward of a line that roughly follows the 60-m bathymetric contour. The areas of the northern GOM that are considered to have a high probability for historic period shipwrecks were redefined as a result of an MMS-funded study (Garrison et al., 1989). The study expanded the shipwreck database in the GOM from 1,500 to more than 4,000 wrecks. Statistical analysis of shipwreck location data identified two specific types of high-probability areas—the first within 10 km of the shoreline, and the second proximal to historic ports, barrier islands, and other loss traps. High-probability search polygons associated with individual shipwrecks were created to afford protection to wrecks located outside of the two aforementioned high-probability areas (see (cf.) Visual 3—Offshore Regulatory Features).

An Archaeological Resources Stipulation was included in all GOM lease sales from 1974 through 1994. The stipulation was incorporated into operational regulations effective November 21, 1994. The language of the stipulation was incorporated into the operational regulations under 30 CFR 250.194 with few changes, and all protective measures offered in the stipulation have been adopted by the regulation.

NTL 2002–G01, issued in December 2001 with an effective date of March 15, 2002, outlines MMS's archaeological survey and report requirements. Survey linespacing at 50 m is required for historic shipwreck surveys in water depths of 200 m or less. Survey linespacing of 300 m is required for prehistoric site surveys and for shipwreck surveys in water depths greater than 200 m.

Several OCS-related, impact-producing factors may cause adverse impacts to archaeological resources. Offshore development could result in a drilling rig, platform, pipeline, dredging activity, or anchors impacting a prehistoric archaeological site or an historic shipwreck. Physical contact with a prehistoric site would cause a disturbance of the site stratigraphy and artifact provenance that would adversely affect the integrity of the site and its research potential. Direct physical contact with a shipwreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb the site context. The result would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel's crew, and the concomitant loss of information on maritime culture for the time period from which the ship dates.

The emplacement of drilling rigs and production platforms has the potential to cause physical impact to prehistoric and/or historic archaeological resources. Pile driving associated with platform emplacement may also cause sediment liquefaction an unknown distance from the piling, disrupting stratigraphy in the area of liquefaction.

Pipeline installation has the potential to cause a physical impact to prehistoric and/or historic archaeological resources.

Anchoring associated with platform emplacement may also physically impact prehistoric and/or historic archaeological resources.

The OCS operations may also generate tons of ferromagnetic structures and debris, which would tend to mask magnetic signatures of significant historic archaeological resources. The task of locating historic resources via an archaeological survey is, therefore, made more difficult as a result of leasing activity.

The dredging of new channels, as well as maintenance dredging of existing channels, has the potential to cause a physical impact to both prehistoric sites and historic shipwrecks (Espey, Huston, & Associates, 1990). There are many navigation channels that provide OCS accesses to onshore facilities.

4.2.1.14.1. Historic

Proposed Action Analysis

The specific locations of archaeological sites in the proposed lease sale area cannot be identified without first conducting a remote-sensing survey of the seabed and near-surface sediments. The MMS, by virtue of new operational regulations under 30 CFR 250.194, requires that an archaeological survey be conducted prior to development of leases within the high-probability zones for historic and prehistoric archaeological resources. A proposed action includes the potential drilling of 11-13 exploration wells and 19-27 development wells over the 40-year life of a proposed action. Approximately 8,000-9,000 service-vessel trips (**Table 4-2**) are estimated for a proposed action; this is a rate of 200-225 service-vessel trips annually.

Of the 256 blocks in the proposed lease sale area, 10 blocks fall within the GOM Region's high-probability area for historic resources. These 10 lease blocks are deepwater blocks and must be surveyed at a minimum 300-m linespacing.

Ferromagnetic debris associated with exploration and production activities has the potential to mask the magnetic signatures of historic shipwrecks.

Onshore historic properties include sites, structures, and objects such as historic buildings, forts, lighthouses, homesteads, cemeteries, and battlefields. Sites already listed on the National Register of Historic Places and those considered eligible for the Register have already been evaluated as being able to make a unique or significant contribution to science. At present, unidentified historic sites may contain unique historic information and would have to be assessed after discovery to determine the importance of the data. However, no new onshore infrastructure is projected as a result of a proposed action.

Deepening and/or widening of navigation channels through maintenance dredging could have the potential to impact historic shipwrecks. The initial maintenance dredging of ports and navigation channels could impact an historic shipwreck if an archaeological survey was not performed. The potential areas of such impact include shore-base ports and their associated navigation channels. Projected primary service bases are the port areas of Venice and Fourchon, Louisiana, and Mobile, Alabama. This includes smaller ports in the area of the larger ports listed. Secondary service bases are Cameron, Intracoastal City, Houma, and Morgan City, Louisiana, and Pascagoula, Mississippi. The current system of navigation channels is believed to be generally adequate to accommodate traffic generated by a proposed action. The navigation channel at Pass Fourchon, Louisiana, is expected to be deepened to accommodate and recruit new business, which includes OCS-related business. All projected service bases and associated navigation channels represent high probability areas for the occurrence of historic period shipwrecks (Garrison, 1989). These areas and activities fall within the jurisdiction of the COE. It is assumed that before maintenance dredging to deepen and/or widen ports and navigation channels would occur the COE would require coordination with appropriate State and Federal agencies and conduct requisite remote-sensing archaeological surveys.

Summary and Conclusion

The greatest potential impact to an archaeological resource as a result of a proposed action would result from a contact between an OCS offshore activity (drilling rig emplacement, platform installation, pipeline installation, or dredging) and a historic shipwreck. The archaeological survey and archaeological clearance of sites required prior to an operator beginning oil and gas activities on a lease are estimated to be highly effective at identifying possible historic shipwreck sites. Since the site survey and clearance provide a substantial reduction in the potential for a damaging interaction between an impact-producing factor and a historic shipwreck, there is a very small possibility of an OCS activity impacting a historic site.

Ten of the blocks offered in the proposed lease sale area fall within the MMS GOM Region's high-probability area for the occurrence of historic shipwrecks and would require a survey at a minimum 300-m linespacing.

Most other activities associated with a proposed action are not expected to impact historic archaeological resources. Ferromagnetic debris has the potential to mask the magnetic signatures of historic shipwrecks. It is expected that onshore archaeological resources would be protected through the review and approval processes of the various Federal, State, and local agencies involved in permitting onshore activities. Deepening and/or widening activities associated with maintenance dredging of navigation channels may result in impacts to historic shipwrecks.

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

4.2.1.14.2. Prehistoric

Prehistoric archaeological resources include sites, structures, and objects such as shell middens, earth middens, campsites, kill sites, tool manufacturing areas, ceremonial complexes, and earthworks. Offshore development as a result of a proposed action could result in an interaction between a drilling rig, platform, pipeline, anchors, or dredging operations and an inundated prehistoric site. Water depths in the proposed lease sale area range from approximately 1,600 to 3,000 m. New pipelines projected as a result of a proposed action would be in <500 m of water. Based on the current acceptable seaward extant of the prehistoric archaeological high probability area for this part of the GOM the extreme water depth precludes the existence of any prehistoric archaeological resources within the proposed lease sale area and projected pipeline corridors.

Proposed Action Analysis

At present, unidentified onshore prehistoric sites would have to be assessed after discovery to determine the uniqueness or significance of the information that they contain. Sites already listed in the National Register of Historic Places and those considered eligible for the Register have already been evaluated as having the potential for making a unique or significant contribution to science. Of the unidentified coastal prehistoric sites that could be impacted by onshore development, some may contain unique information. However, no new onshore infrastructure is projected as a result of a proposed action.

The projected deepening of the Pass Fourchon navigation channel could impact a prehistoric site. Protection of archaeological resources in this case is expected to be accomplished by the required coordination by COE with appropriate State and Federal project review and permitting agencies.

Summary and Conclusion

Since no new onshore infrastructure is projected as a result of a proposed action and no prehistoric sites are located within the proposed lease sale area, a proposed action is not expected to result in impacts to prehistoric archaeological sites.

4.2.1.15. Impacts on Human Resources and Land Use

This proposed action analysis considers the effects of OCS-related, impact-producing activities from a proposed EPA lease sale in relation to the continuing baseline of non-OCS-related factors. Non-OCS factors include fluctuations in workforce, net migration, relative income, oil and gas activity from State waters, wetland loss, and tropical storms. Unexpected events that may influence oil and gas activity within the analysis area but cannot be predicted are not considered in this analysis.

4.2.1.15.1. Land Use and Coastal Infrastructure

Proposed Action Analysis

Chapters 3.3.5.1.2. and 3.3.5.8. discuss land use and OCS-related oil and gas infrastructure associated with the analysis area. The existing oil and gas infrastructure is expected to be sufficient to handle activities associated with a proposed action. The OCS activities from past and future OCS lease sales would continue to occur, and related impacts would continue even in the absence of a proposed action.

Summary and Conclusion

A proposed action in the EPA of its own accord would not require additional coastal infrastructure or alter the current land use of the analysis area.

4.2.1.15.2. Demographics

In this section, MMS projects how and where future demographic changes would occur and whether they correlate with a proposed EPA lease sale. The addition of any new human activity, such as oil and gas development resulting from a proposed action, can affect local communities in a variety of ways. Typically, these effects are in the form of people and money, which can translate into changes in the local social and economic institutions and land use.

Proposed Action Analysis

Population

Population projections related to activities resulting from a proposed action are expressed as total population numbers and as a percentage of the population levels that would be expected if a proposed action did not occur (**Tables 4-22 and 4-23**). **Chapter 3.3.5.4.1.** discusses baseline population projections for the analysis area. Because the baseline projections assume the continuation of existing social, economic, and technological trends, they also include population changes associated with the continuation of current patterns in OCS Program activities. Population impacts from a proposed action mirror the assumptions for employment impacts described in **Chapter 4.2.1.15.3.**, Economic Factors, below. Projected population changes reflect the number of people dependent on income from OCS-related employment for their livelihood, which is based on the ratio of population to employment in the analysis area over the life of a proposed lease sale.

Population associated with a proposed action in the EPA is estimated at 3,950-27,100 persons during the peak years of impact (years 5 and 6) for the low- and the high-case scenarios, respectively. It is during those years of peak population that a substantial amount of platform and pipeline installations are projected in association with a proposed action in the EPA. Platform fabrication and installation, and pipeline installation activities are labor intensive and tend to occur concurrently, therefore, leading to employment and population impacts.

Population impacts from a proposed action in the EPA are expected to be minimal, i.e., less than 1 percent of total population for any coastal subarea. The mix of males to females is expected to remain unchanged. The increase in employment is expected to be met primarily with the existing population and available labor force, with the exception of some in-migration (some of which may be foreign) projected to move into focal areas, such as Port Fourchon, due to the labor supply/demand imbalance for some onshore oil and gas infrastructure industries in these areas (**Chapter 4.1.2.1.**, Coastal Infrastructure).

Age

If a proposed EPA lease sale is held, the age distribution of the analysis area is expected to remain virtually unchanged. Given both the low levels of population growth and industrial expansion associated with a proposed action, the age distribution pattern discussed in **Chapter 3.3.5.4.2.** is expected to continue through the year 2042. Activities relating to a proposed action in the EPA are not expected to affect the analysis area's median age.

Race and Ethnic Composition

The racial distribution of the analysis area is expected to remain virtually unchanged if a proposed action in the EPA is held. Given the low levels of employment and population growth and the industrial expansion projected for a proposed action, the racial distribution pattern described in **Chapter 3.3.5.4.3.** is expected to continue through the year 2042.

Education

Activities relating to a proposed EPA lease sale are not expected to significantly affect the analysis area's educational levels. Given the low levels of employment and population growth and the industrial expansion projected for a proposed action, the analysis area's education status, described in **Chapter 3.3.5.4.4.**, is expected to continue through the year 2042. Activities relating to a proposed action in the EPA are not expected to affect the analysis area's educational attainment.

Summary and Conclusion

Activities relating to a proposed EPA lease sale are expected to minimally affect the analysis area's land use, infrastructure, and demography. These impacts are projected to mirror employment effects that are estimated to be negligible to any one subarea. Baseline patterns and distributions of these factors, as described in **Chapter 3.3.5.**, Human Resources and Land Use, are expected to maintain. Changes in land use throughout the analysis area are expected to be contained and minimal. The OCS-related infrastructure is in place and would not change as a result of a proposed action. Current baseline estimates of population growth for the analysis area show a continuation of growth, but at a slower rate.

4.2.1.15.3. Economic Factors

The importance of the oil and gas industry to the coastal communities of the GOM is significant, particularly in south Louisiana, eastern Texas, and coastal Alabama. Dramatic changes in the level of OCS oil and gas activity over recent years have resulted in parallel fluctuations in population, labor, and employment in the analysis area. The economic analysis for a proposed lease sale in the EPA focuses on the potential direct, indirect, and induced impacts of the OCS oil and gas industry on the population and employment of the counties and parishes in the analysis region defined in **Chapter 3.3.5.1.**, Socioeconomic Analysis Area. To improve regional economic impact assessments and to make them more consistent with each other, MMS developed a new methodology for estimating changes to employment and other economic factors. The methodology developed to quantify these impacts on population and employment takes into account changes in OCS-related employment, along with population impacts resulting from these employment changes within each individual subarea.

The GOM region model has two steps.

(1) Because there are no publicly available models that estimate the expenditures resulting from offshore oil and gas activities, the model first estimates expenditures for 10 scenario activities projected to result from a proposed action in the EPA. These activities include exploratory drilling, development drilling, production operations and maintenance, platform fabrication and installation, pipeline construction, pipeline operations and maintenance, gas processing and storage construction, gas processing and storage operations and maintenance, workovers, and platform removal and abandonment. The model then assigns these expenditures to industrial sectors in the 10 subareas defined in **Chapter 3.3.5.1.**, **Figure 3-10**.

(2) The second step in the model uses multipliers from the commercial input-output model IMPLAN (using 1999 data, the latest available data) to translate these expenditures into direct, indirect, and induced employment and other economic factors. Direct employment results from the first round of industry spending. It is the employment that results from the initial dollars spent by the oil and gas industry on the 10 scenario activities (listed above). Indirect employment results as the initial spending reverberates through the economy. First, the suppliers of the goods and services for the 10 activities spend the initial direct dollars from the industry. Then, these dollars are re-spent by other suppliers until the initial dollars have trickled throughout the economy. Households spending the resulting labor income creates induced employment.

Both the level (the amount spent) and the sectoral (the industry in which it is spent) allocation of expenditures can vary considerably by the phase of OCS activity and by the water depth of the OCS activities. For example, an exploratory well in 0-60 m of water is expected to be drilled using a jack-up rig and to cost about $4 million; whereas, an exploratory well in 800 m or greater water depth is expected to be drilled using a drillship and to cost in excess of $10 million to complete. All activities associated with a proposed action in the EPA are in water depths of 800 m or greater. In addition, spending on materials such as steel would be much higher for platform fabrication and installation than for operations and maintenance once production begins. Therefore, the model estimates and allocates expenditures for the 10 scenario activities. Because local economies vary, a separate set of IMPLAN multipliers is used for each coastal subarea to which expenditures are assigned. Each set of multipliers is based on the actual historical patterns of economic transactions in the area. Model results for employment are presented in the number of jobs per year, where one job is defined as a year of employment. This does not necessarily mean only one person occupies the position through out the year. One job may be equal to two part-time positions occupied over the year or one person occupying a position for 6 months, while another person occupies it for the other 6 months.

The projections in this section are not statements of what would happen but of what might happen, given the assumptions and methodologies used. The projections are business-as-usual trend forecasts, given known technology, technological and demographic trends, and current laws and regulations. Because energy markets are complex, models are simplified representations of energy production and consumption, regulations, and producer and consumer behavior. Projections are highly dependent on the data, methodologies, model structures, and assumptions used in their development. Energy projections are subject to much uncertainty. Many of the events that shape energy markets are random and cannot be anticipated, including severe weather, political disruptions, strikes, and technological breakthroughs. In addition, future developments in technologies, demographics, and resources cannot be foreseen with any degree of certainty. Given this, MMS has endeavored to make these projections as objective, reliable, and useful as possible (USDOE, EIA, 2001b).

Proposed Action Analysis

Total employment projections for activities resulting from a proposed action are expressed as absolute numbers and as a percentage of the employment levels expected if no development occurs (**Tables 4-24 and 4-25**). The baseline projections of population and employment used in this analysis are described in **Chapters 3.3.5.4. and 3.3.5.5.** (**Tables 3-17 through 3-32**). Because these baseline projections assume the continuation of existing social, economic, and technological trends, they also include employment resulting from the continuation of current patterns in OCS Program activities. Population impacts, described in **Chapter 4.2.1.15.2.**, Demographics, (**Tables 4-29 and 4-30**), mirror those assumptions associated with employment. Projected population changes reflect the number of people dependent on income from oil- and gas-related employment for their livelihood. This figure is based on the ratio of population to employment in the impact region over the life of a proposed lease sale.

Based on model results (**Table 4-24**), direct employment associated with a proposed EPA lease sale is estimated at 1,300-9,000 jobs during peak impact years 5 and 6 for the low- and high-case scenarios, respectively. Indirect employment is projected at 450-3,200 jobs, while induced employment is calculated to be 540-3,500 jobs, for the low- and high-case scenarios, respectively. Therefore, total employment resulting from a proposed lease sale in the EPA is not expected to exceed 2,300-15,700 jobs in any given year over a proposed action's 40-year lifetime. Employment associated with a proposed EPA lease sale is projected to peak in years 5 and 6, which are the projected peak years for platform and pipeline installation activities in support of a proposed action. Platform fabrication and installation, and pipeline installation activities are labor intensive and tend to occur concurrently.

Although most of the employment (on an absolute basis) related to a proposed action is expected to occur in coastal Subarea TX-2 (this is due to offshore oil and gas corporate offices headquartered in Houston and the abundant offshore oil and gas infrastructure in this coastal subarea), employment is not expected to exceed 1 percent of the total employment in any given coastal subarea of Texas, Louisiana, Mississippi, or Alabama (**Table 4-25**). On a percentage basis, coastal Subareas LA-1, LA-2, LA-3, and MA-1 (this is due to the vast offshore oil and gas infrastructure in the coastal subareas) are projected to have the greatest employment impact at 0.3 percent each. Considering Florida's current opposition to oil and gas development in offshore waters and the scarcity, if not absence, of onshore supporting service bases, MMS anticipates that very few OCS-related activities would be staged from Florida. Model results concur there would be little to no economic stimulus to the Florida analysis region as a result of a proposed action in the EPA.

Summary and Conclusion

Should a proposed EPA lease sale occur, there would be only minor economic changes in the Texas, Louisiana, Mississippi, and Alabama coastal subareas. A proposed action is expected to generate less than a 1 percent increase in employment in any of these subareas. This demand would be met primarily with the existing population and available labor force. There would be very little to no economic stimulus in the Florida subareas.

4.2.1.15.4. Environmental Justice

The analysis of environmental justice concerns is divided into those related to routine operations (below) and those related to oil spills (**Chapter 4.4.14.4.**). Concerns related to routine operations center on increases in onshore activity (such as employment, migration, commuter traffic, and truck traffic) and on additions to the infrastructure supporting this activity (such as fabrication yards, supply ports, and onshore disposal sites for offshore waste). **Chapter 3.3.5.8.** describes the widespread presence of an extensive OCS support system and associated labor force, as well as economic factors related to OCS activities.

Proposed Action Analysis

Environmental justice issues involve questions of disproportionate and negative effects on minority and low-income populations. A proposed action is expected to increase slightly employment opportunities in a wide range of businesses along the Gulf Coast. These conditions preclude a prediction of where much of this employment would occur or who would be hired. **Figures 3-14 and 3-15** provide distributions of census tracts of high concentrations of minority groups and low-income households. As stated in **Chapter 3.3.5.4.**, Demographics, pockets of concentrations of these populations are scattered throughout the GOM coastal counties and parishes. Many of these populations are in large urban areas where the complexity and dynamism of the economy and labor force preclude a measurable effect. Low-income populations are almost exclusively minority and urban. Because the distribution of low-income and minority populations does not parallel the distribution of industry activity, effects of a proposed action are not expected to be disproportionate.

The widespread economic effects of a proposed action on minority and low-income populations are not expected to be negative. Ongoing MMS research includes gathering information on race and employment. Offshore workers in the production sector are almost entirely male and white (Rosenberg, personal communication, 2001). Other sectors, such as the fabrication industry and support industries (e.g., trucking), employ minority workers and provide jobs across a wide range of pay levels and educational/skill requirements (Austin et al., 2002a and b; Donato et al., 1998). A study of oil industry trends between 1980 and 1990 found that downsizing was concentrated in the production sector; therefore, it affected white male employment more than that of women or minorities (Singelmann, in preparation). Evidence also suggests that a healthy offshore petroleum industry also indirectly benefits low-income and minority populations. One MMS study in Louisiana found income inequality decreased during the oil boom and increased with the decline (Tolbert, 2001). Another MMS-funded study found that reemployment rates for poorly educated black and white women laid off in the closing of an OCS-related plant in one rural town were much higher than reemployment rates related to similar closings elsewhere because Louisiana's oil industry had created a complex local economy (Tobin, 2001). While a proposed action would provide little additional employment, it would have the effect of maintaining current activity levels, which is expected to be beneficial to low-income and minority populations.

Environmental justice often concerns the possible siting of infrastructure in places that would have disproportionate and negative effects on minority and low-income populations. Since a proposed action would help to maintain ongoing levels of activity rather than expand them, no one proposed lease sale would generate significant new infrastructure demand. For this reason, this EIS considers infrastructure projections only for the cumulative analysis (**Chapter 4.4.14.4.**). The cumulative analysis concludes that, as with the analysis of employment effects of a proposed action, infrastructure effects are expected to be widely and thinly distributed. Since the siting of new infrastructure would reflect the distribution of the petroleum industry and not that of minority and low-income populations, OCS activity is not expected to disproportionately effect these populations. Lafourche Parish is identified as a location of concentrated effects. Each OCS-related facility constructed onshore must first receive approval by the relevant Federal, State, county or parish, and community involved. MMS assumes that new construction would be approved only if consistent with appropriate land-use plans, zoning regulations, and other State/regional/local regulatory mechanisms.

Because of Louisiana's extensive oil-related support system (**Chapter 3.3.5.8.**, OCS-Related Coastal Infrastructure), that State is likely to experience more employment effects related to a proposed action than are the other coastal states. This is confirmed in the economic factors section (**Chapter 4.2.1.15.3.**). Lafourche Parish, Louisiana, is likely to experience a large concentration and is the only parish where additional OCS-related activities and employment are sufficiently concentrated enough to increase stress to its infrastructure. However, effects of a proposed action are not expected to be significant in the long term.

The concentrated socioeconomic impacts in Lafourche Parish are not expected to have disproportionate effects on minority and low-income populations for several reasons. The parish is not predominately minority or low income (**Figures 3-14 and 3-15**). The Houma, a Native American tribe recognized by the State of Louisiana, has been identified by MMS as a possible environmental justice concern. The MMS is currently funding a study focused on Lafourche Parish and the Houma. Available information indicates that the Houma are not expected to be disproportionately affected because they are not residentially segregated but, rather, live interspersed among the non-minority population (Fischer, 1970).

Two local infrastructure issues described in **Chapter 3.3.5.2.**, How OCS Development Has Affected the Analysis Area, could possibly have related environmental justice concerns: traffic on LA 1 and the Port Fourchon expansion. Neither, however, are expected to disproportionately affect minority or low-income populations. Increased traffic may have health risks (e.g., increased accident rates). However, as described in **Chapter 3.3.5.1.**, Socioeconomic Analysis Area, human settlement patterns in the area (on high ground along LA 1 and Bayou Lafourche) mean that rich and low-income alike would be affected by any increased traffic. Port Fourchon is relatively new and is surrounded by mostly uninhabited land. Existing residential areas close to the port are also new and not considered low-income areas. Any expansion of infrastructure at Port Fourchon is not expected to disproportionately affect minority or low-income populations. Lafourche Parish is an area of relatively low unemployment because of the concentration of petroleum-related industry in the area (Hughes, 2002). While the minority and low-income populations of Lafourche Parish would share with the rest of the parish population any negative impacts related to a proposed action, most effects related to a proposed action would be economic and positive.

Summary and Conclusion

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

Lafourche Parish would experience the most concentrated effects of a proposed action; however, because the Parish is not heavily low-income or minority, because the Houma are not residentially segregated, and because the effects of road traffic and port expansion would not occur in areas of low-income or minority concentration, these groups would not be differentially affected. In general, the effects in Lafourche Parish are expected to be mostly economic and positive. A proposed action would help to maintain ongoing levels of activity rather than expand them.

4.2.2. Alternative B – No Action

Description of the Alternative

Alternative B is equivalent to cancellation of a lease sale scheduled for a specific period in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007.* By canceling a proposed lease sale, the opportunity is postponed or foregone for development of the estimated 0.065-0.085 BBO and 0.265-0.340 Tcf of gas. Any potential environmental impacts resulting from a proposed sale (**Chapter 4.2.1.**, Alternative A – The Proposed Actions) would not occur or would be postponed.

Effects of the Alternative

Under Alternative B, the U.S. Dept. of the Interior cancels a planned Eastern GOM lease sale. Therefore, the oil expected from a lease sale would remain undiscovered and undeveloped. The environmental effects of Alternative A (proposed action) also would not occur. Other sources of energy would need to substitute for the lost production. Principal substitutes would be additional imports, conservation, additional domestic production, and switching to other fuels. These alternatives, except conservation, have significant negative environmental impacts of their own.

This section briefly discusses the most likely alternative sources, the quantities expected to be needed, and the environmental impacts associated with the alternatives. The discussion is based on material from the following MMS publications: *Final Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007, Decision Document* (USDOI, MMS, 2002a); *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007, Final Environmental Impact Statement* (USDOI, MMS, 2002b); and *Energy Alternatives and the Environment* (USDOI, MMS, 2001d). These sources are incorporated into this document by reference.

Most Important Substitutes for Production Lost through No Lease Sale

Energy Alternatives and the Environment discusses a long list of potential alternatives to natural gas and oil. However, most substitutes for the natural gas and oil from the lease sale would come from four sources:

- additional imports;
- conservation;
- additional domestic production; and
- fuel switching.

Additional domestic production and imports would augment supply, while conservation and switching to alternative fuels shift demand downward. The table below shows the percentage and range of quantities expected to be needed to substitute for the lost natural gas and oil production. The quantities for conservation and fuel switching are in equivalent energy units.

Substitutes for Natural Gas and Oil Lost Because of No Lease Sale

Source	Percent of Lost Oil Production	Range of Oil Quantity (MMbbl)	Percent of Lost Gas Production	Range of Gas Quantity (Bcf)
Imports	86-88%	56-75	16%	42-54
Conservation	6-7%	5	16-17%	45-54
Additional Domestic Production	3%	2-3	26-28%	69-95
Fuel Switching	4-5%	3	40-42%	111-136
Total Production Lost through No Sale	100%	65-85	100%	265-340

Notes: Bcf – billion cubic feet.
MMbbl – million barrels.

Environmental Impacts from the Most Important Substitutes

Additional Imports: Significant environmental impacts from an increase in oil imports include the following:

- generation of greenhouse gases and air pollutants from both transport and dockside activities (emissions of NO_x, SO_x, and VOC's have an impact on acid rain, tropospheric ozone formation, and stratospheric ozone depletion);
- degradation of water quality from oil spills related to accidental discharges or tanker casualties;
- oil-spill contact with flora, fauna, or recreational and scenic land and water areas; and
- increasing public concern about tanker spills.

Imported oil may also impose negative environmental impacts in producing countries and in countries along trade routes. Additional imports of natural gas would require construction of new pipelines from the most likely sources—Canada and Mexico. Pipeline construction can disrupt wildlife habitat, lead to increased erosion, and add to the siltation of streams and rivers.

Conservation: Conservation is composed of two major components:

- substituting energy-saving technology, often embodied in new capital equipment, for energy resources (e.g., adding to home insulation); and
- consuming less of an energy-using service (e.g., turning down the thermostat in an office during the winter).

Consuming less of an energy service is positive from an environmental perspective. Substituting energy-saving technology would tend to result in positive net gains to the environment. The amount of gain would depend on the extent of negative impacts from capital equipment fabrication.

Additional Domestic Production: Onshore oil and gas production has notable negative impacts on surface water, groundwater, and wildlife. It can also cause negative impacts on soils, air pollution, vegetation, noise, and odor. Offshore oil and gas production imposes the risk of oil spills affecting water quality, localized degradation of air quality, potential impacts on coastal wetlands dependent wildlife, and shoreline erosion from additional supply boat traffic. Offshore activities may also have negative impacts on social, cultural, and economic measures such as recreation.

Fuel Switching: The most likely substitutes for natural gas are oil, which would further increase imports, and coal for use in electricity generation. Coal mining causes severe damage to land and wildlife habitat. It also is a major contributor to water quality deterioration through acid drainage and siltation. Alternative transportation fuels may constitute part of the oil substitution mix. The mix depends on future technical and economic advances. No single alternative fuel appears to have an advantage at this time. Every fuel alternative imposes its own negative environmental effects.

Other Substitutes

Government could also impose other substitutes for natural gas and oil. The most likely sectors to target would be transportation, electricity generation, or various chemical processes. *Energy Alternatives and the Environment* discusses many of the alternatives at a level of detail impossible here.

Summary and Conclusion

Canceling a lease sale would eliminate the effects described for Alternative A (**Chapter 4.2.1.**). Other sources of energy would substitute for the lost production. Principal substitutes would be additional imports, conservation, additional domestic production, and switching to other fuels. These alternatives, except conservation, have significant negative environmental impacts of their own.

4.3. IMPACT-PRODUCING FACTORS AND SCENARIO – ACCIDENTAL EVENTS

The NEPA requires Federal agencies to consider potential environmental impacts (direct, indirect, and cumulative) of proposed actions as part of agency planning and decisionmaking. The NEPA analyses address many issues relating to potential impacts, including issues that may have a very low probability of occurrence, but which the public considers important or for which the environmental consequences could be significant.

The past several decades of data show that accidental spills ≥1,000 bbl associated with oil and gas exploration and development are low probability events in Federal OCS waters of the GOM.

This section describes accidental events associated with a proposed action, the Gulfwide OCS Program, and non-OCS activities that could potentially affect the biological, physical, and socioeconomic resources of the GOM. These include oil spills, blowouts, vessel collisions, and spills of chemicals or drilling fluids.

4.3.1. Oil Spills

4.3.1.1. Background

This section provides information and data for the following: (1) spills that have occurred from OCS operations and non-OCS operations; (2) estimated rates of oil spill occurrences, based on analysis of past spills; (3) projections of oil spills from OCS future operations and from other potential sources in the GOM area; (4) known OCS oil characteristics; (5) MMS spill prevention and spill preparedness and response plan requirements; and (6) industry capabilities to respond to spill incidents.

OCS spills are spills to U.S. waters from operations occurring due to oil and gas extraction activities that are a result of an OCS lease sale. They include spills that occur at offshore oil or gas development sites; spills that occur along routes used to transport oil and gas, services, and products back and forth from coastal support bases to offshore development sites; and spills that occur at onshore or coastal locations from support operations for the OCS oil and gas industry. The U.S. waters included are all marine waters, coastal waters, and inland waters of the coastal zone.

Non-OCS spills are all other spills that occur in U.S. waters.

4.3.1.1.1. Past Spill Incidents

4.3.1.1.1.1. Past Record of OCS Offshore Spills

The MMS maintains public records of OCS spills from activities that MMS regulates. The OCS offshore oil spills are spills that occur in Federal waters from OCS facilities and pipeline operations. The OCS facilities include drilling rigs, drillships, and storage, processing, or production structures that are used during OCS drilling, development, and production operations. The OCS offshore spills from pipeline operations are those that occur on the OCS and are directly attributable to the transportation of OCS oil.

Table 4-26 summarizes records on OCS offshore oil spills for seven different spill-size groupings for the period 1985-1999. Spill records for the period 1985-1999 are displayed because this time period is used in the EIS to project future spill risk. The period 1985-1999 is the most recent period for which spill statistics are available and best reflects current spill prevention and occurrence conditions. For the period 1985-1999, data are provided on the total number of spills, number of spills by operation, total volume of oil spilled, and the spill rate calculated from data on historical spills and production. The average spill size and median spill size during this period are given for each spill-size category.

Tables 4-27 and 4-28 provide information on OCS offshore oil spills ≥1,000 bbl that have occurred for the entire period that records are available (1964-2000), rather than just the 15-year time period discussed above in order to give the reader the entire history of spills ≥1,000 bbl. The data show that there were eight pipeline spills ≥1,000 bbl during the period 1985-1999. These occurred as the result of damage caused by anchors, fishing trawls, and hurricanes. During this same time period (1985-1999), there were no OCS spills ≥1,000 bbl from offshore facility operations.

The data from 1985 to 1999 are divided into two groups based on whether the spill was caused by an accident on a drilling or production facility or if the spill was caused by an accident during pipeline transport. The record shows that pipeline spills have occurred less frequently compared to spills at drilling and production facilities, but they have resulted in spills with the most volume, with the rate of spills ≥1,000 bbl continuing to increase over time. In contrast, since 1985, accidents during drilling and production have not resulted in any offshore spills ≥1,000 bbl, even though they make up about 75 percent of all OCS spills <50 bbl.

The data show that about 97 percent of OCS offshore oil spills have been ≤1 bbl (**Figure 4-6**). Although spills of ≤1bbl account for most OCS-related spill occurrences, spills of this size have contributed little (3%) to the total volume of OCS oil spilled. Most of the total volume of OCS oil spilled (90%) has been from spills ≥5 bbl.

Between 1985 and 1999, OCS operators produced about 5.81 BBO, and the amount of OCS oil spilled offshore totaled about 46,000 bbl. This amount is 8 x 10^{-6} percent of the amount produced, or 1 bbl spilled for about every 125,000 bbl of oil produced.

4.3.1.1.1.2. Past Record of OCS Coastal Spills

The OCS spills have occurred in coastal waters at shoreline storage, processing, or transport facilities supporting the OCS oil and gas industry and in State offshore waters and in navigation channels, rivers, and bays from barges and pipelines carrying OCS-produced oil. Only the USCG (USDOT, CG, 2001a) maintains records of spills in coastal waters and State offshore waters, but the database does not identify if the cause or source of the spill is related to OCS versus non-OCS activities. A pipeline carrying oil from a shore base to a refinery may be carrying oil stored from both State and OCS production; imported oil might also be commingled in the pipeline. Therefore, there are no past records available that contain only spills that have occurred in State offshore or coastal waters directly as a result of OCS oil and gas development. A portion of all coastal spill data is used in the analysis of spills presented in this document. A discussion of the numbers, volumes, and causes, for all coastal spills that have occurred in the GOM area is found below.

4.3.1.1.1.3. Past Record of All (OCS and non-OCS) Spills

Besides spills occurring from OCS oil and gas operations, oil spills have occurred from a large number of other sources, particularly from the extensive maritime industry that uses vessels to transport crude oil and petroleum products within the GOM and from other countries and states to GOM refineries and ports. Other sources include State oil and gas development operations and infrastructure, trucks, railcars, and mystery sources. The record for all spills that have occurred from 1973 to 2000 into U.S. navigable waters (including OCS and non-OCS spills) can be found at http://www.uscg.mil/hq/g-m/nmc/response/stats/Summary.htm (USDOT, CG, 2001a). Information on the number and size of tanker and barge spills ≥1,000 bbl that have occurred in U.S. waters and worldwide can be found in a recently published report by MMS (Anderson and LaBelle, 2000).

The following is a summary of what is known about trends in U.S. spill risk and is derived from analysis of 1973-2000 USGS data (USDOT, CG, 2001a) and Rainey (1992). This time period was used for this analysis rather than the 15-year time period used in the analysis of OCS spill data because the trend analysis completed by the USCG shows a steady trend spread over the entire time period rather than a distinct change relative to particular years.

Volumes Spilled

The total volume spilled from all spill incidents per year and the volume spilled per spill incident in U.S. waters has been on a steady downward trend since 1973. There have been no oil spills over 23,800 bbl (1 million gallons (gal)) since 1991. The majority of spills since 1973 involved discharges between 0.02 and 2.4 bbl (1 and 100 gal). The decline in oil-spill volume, particularly in the face of growing domestic demand for imported oil, represents the combined effects of an increasingly effective campaign of positive prevention and preparedness initiatives to protect U.S. coastal waters from oil pollution (USDOT, CG, 2001a). The total volume of oil spilled per year is declining. The total volume spilled in 2000 is at the lowest amount in over 25 years.

Number of Spills

A review of the USCG data shows that the total number of spill incidents occurring in U.S. waters has remained relatively constant from year to year. Since 1973, the number has varied between about 8,000 and 10,000 spills per year, with the exception of the mid 1980's when the numbers dipped below 4,000 spills. For GOM offshore waters, the number of incidents has slightly increased from pre-1990, peaking at about 2,400 spills in 1996.

Sources of Spills

Spills from tank vessels (ships and barges carrying oil) account for the majority of volume spilled. Thirty-two percent of the number of all spills from 1973 to 2000 occurred from non-tank vessels; 25.2 percent were “mystery” spills; 29.1 percent were from facilities and other non-vessels; 10.2 percent were from tank vessels; and 3.5 percent were from pipelines. From 1973 to 2000, 46.8 percent of the volume of oil spilled came from tank vessels; 22 percent from facilities and other non-vessels; 17.5 percent from pipelines; 7.7 percent from mystery spills; and 5.9 percent from non-tank vessels. The rates for oil spills ≥1,000 bbl from OCS platforms, tankers, and barges continues to decline, while the rate for OCS pipeline spills has increased. The majority of spills ≥1,000 bbl has occurred from vessels near terminals and are associated with coastal barging operations of petroleum products (Rainey, 1992).

Types of Oil Spilled

Crude oil and heavy oil accounted for the majority of the volume spilled (62%). Crude oil and heavy oil were the most frequent types of oil spilled (36% of the number of spills from 1973 to 2000 were the discharge of crude oil or heavy oil).

Location of Spills

About 75 percent of all spills and 83.8 percent of the volume of all spills occurred in waters 0 to 3 miles from shore. Overall, 63.7 percent of all spills from 1973 to 2000 occurred in the GOM area or within rivers draining into the GOM. For coastal spills sorted by type of waterbody: 47 percent have occurred in rivers and canals; 18 percent in bays and sounds; and 35 percent in harbors. For coastal spills sorted by coastal water designation: 32 percent of all coastal spills occur in State offshore waters 0-3 mi from shore; 4 percent occur in State offshore waters 3-12 mi from shore; and 64 percent occur in inland waters.

Louisiana has experienced the majority of large vessel spills. Rainey (1992) identified that, during 1974-1990 for oil spills ≥1,000 bbl, there have been 27 spills in Texas, 38 in Louisiana, 2 in Mississippi, 4 in Alabama, and 3 in Florida. The majority of these spills occurred on the Mississippi River, making the Mississippi River the most likely location of coastal spills.

The MMS also reviewed specific historical information on spill occurrence in the Mississippi/Alabama/Northwest Panhandle Florida, an area where little oil and gas support operations currently occur (USDOT, CG, 1995). There does not appear to be a difference between the causes of spills within the coastal waters of these States and what is expected for the entire GOM area. The USCG Contingency Plan for this area provides the following data. Between 1985 and 1989, the Mississippi/Alabama coastal area experienced 21 spills >12 bbl, 12 spills between 12 and 50 bbl, 7 spills between 50 and 1,000 bbl, and 2 spills ≥1,000 bbl. Of the 13 spills for which the source was identifiable, 6 spills were from vessel rupture/collisions, 4 were from tank overflows or breaks, 2 were from transfer hose ruptures, and 1 was from a pipeline. The two spills ≥1,000 bbl were caused by hull ruptures on vessels. Both large spills were a mixture of petroleum products. The USCG also estimated that the maximum probable spill risk would be at the Mobile/GIWW ship channel junction and would be a spill of 14,700 bbl. The records show that the primary source of spills in this area has been vessels bringing in petroleum products to meet these states' energy demands.

Between 1985 and 1989, the Florida northwestern coastal area experienced nine oil spills. All except one were small spills (between 12 and 50 bbl). One of these spills was from a fishing vessel. The one spill >50 bbl was a grounding of a vessel and hull rupture where 190 bbl of jet fuel were spilled. The USCG estimated that the average spill occurring within the Florida Panhandle area has been a petroleum product spill of diesel oil of about 70 bbl (**Chapter 4.3.1.1.2.**, Projections of Spill Incidents).

The MMS examined a number of variables that could serve as indicators of future spill occurrences and uses the volume of oil handled to approximate future risk of spill occurrence. Therefore, spill rates are calculated based on the assumption that spills occur in direct proportion to the volume of oil handled. The rate of spill occurrence is expressed as the number of spills per billion barrels of oil handled. A recently published paper by MMS provides more information on OCS spill-rate methodologies and trends (Anderson and LaBelle, 2000).

Spill records for the most recent period analyzed, 1985-1999, is used to project future spill risk from OCS operations for this EIS because data for this period reflect recent spill prevention and occurrence conditions. The 15-year record reflects how the spill rates have changed while still maintaining a significant portion of the record.

The spill rates for various spill-size categories and both OCS and non-OCS sources used to develop the estimated number of spills in this EIS are provided in **Table 4-29**. This table provides a comparison of estimated spill rates for OCS spills versus spill rates for other kinds of operations in the GOM.

4.3.1.1.2. Projections of Spill Incidents

Detailed projections on spills that could happen from a proposed action are provided in **Chapter 4.3.1.2.**, Risk Charaterization for Proposed Action Spills. Impacts associated with oil spills as a result of a proposed action are analyzed in **Chapter 4.4.** This section provides projections of future spill incidents associated with the OCS Program and other activities and puts into perspective spill risk associated with a proposed action. Impacts associated with the oil spills for all sources are analyzed in the cumulative analyses (**Chapter 4.5.**).

Table 4-15 provides the assumed number of spill events that could occur within coastal and offshore waters of the GOM area for a representative future year (2015). A total volume and number of spills over the 40-year analysis period could be calculated by multiplying the annual numbers shown in **Table 4-15**

times 40. However, MMS recognizes that there is a great deal of uncertainty in the estimates of the number and volumes of spills from sources other than OCS production because these sources are not regulated by MMS. **Table 4-30** shows an estimate of spills as a result of the OCS Program over the 40-year analysis period.

Table 4-15 provides the assumed number of spill events that could occur within coastal and offshore waters of the GOM area for a representative future year (chosen to be 10 years after a proposed lease sale). No annual average over the 40-year analysis period for all spills is appropriate because the timeframes and peak years vary for the different types of activities that could spill oil. For example, State oil production in the U.S. is expected to decline over the next 15 years or so. Because the energy needs of this Nation are projected to continue to increase, any decline in domestic oil production must be replaced by imports of both crude oil and petroleum products from outside this country or replaced by alternative energy sources.

The projections of future spill occurrences shown in **Table 4-15** were formulated using the following sources: a USCG database on spill incidents in all navigable waters (USDOT, CG, 2001a); an MMS spill database; an analysis of spills ≥1,000 bbl from OCS operations (Anderson and LaBelle, 2000); an analysis of spills from tanker and barge operations (Anderson and LaBelle, 2000); and a 1992 analysis of tanker and barge spills as a function of volumes of oil moved in GOM waters by various transport modes (Rainey, 1992). **Table 4-29** provides the spill occurrence rates used by MMS to make these projections. Database information was supplemented by personal communications with a number of individuals dealing with vessel transport and oil-spill incidents in the GOM area.

Summarized data on spill incidents of any size and source that occurred in the GOM was not available at the time of writing this document. As almost 38 percent of all U.S. spills have occurred within GOM waters and Gulf Coast States, the trends for all U.S. spills is assumed to be representative of trends in spills that have occurred in the GOM. Therefore data containing the past record for all U.S. spills was used to develop information on spill risk in GOM waters, whenever data specific to GOM occurrences are lacking.

4.3.1.1.2.1. Projections of Offshore Spills from OCS Program Operations

In order to understand the incremental contribution of a proposed action to the risk of spills for all OCS operations, MMS estimates the number of spills and the probability of one or more spills occurring as a result of the OCS Program—all future OCS oil exploration, development, and production (during the proposed action analysis period). Discussion of the methodology used to develop the assumed number and the probabilities of occurrence for OCS spills is presented in **Chapter 4.3.1.2.** as part of the analysis of a proposed action.

Probability of OCS Offshore Spills ≥1,000 bbl Occurring

The probabilities of one or more offshore spills ≥1,000 bbl occurring from future OCS operations are provided in **Table 4-30**. For the Gulfwide OCS Program, there is a greater than 99 percent chance that there would be an offshore spill ≥1,000 bbl occurring in the next 40 years. For the EPA OCS Program, there is a 19-43 percent chance that there would be an offshore spill ≥1,000 bbl in the next 40 years. For further information, see Ji et al. (2002).

Probability of OCS Offshore Spills ≥10,000 bbl Occurring

The probabilities of one or more offshore spills ≥10,000 bbl occurring from future OCS operations are provided in **Table 4-30**. This is a subset of projections for spills ≥1,000 bbl. For the Gulfwide OCS Program, there is greater than a 99 percent chance that one or more spills ≥10,000 bbl would occur in the next 40 years. For the EPA OCS Program, there is a 5-13 percent chance that there would be an offshore spill ≥10,000 bbl in the next 40 years.

Number of OCS Offshore Spills ≥1,000 bbl

Based on a statistical analysis of spill rates and assumed sources, and using the low and high resource estimates for the OCS Program (**Chapter 4.1.1.1.1.**, Proposed Action), MMS assumed the mean number of offshore oil-spill events estimated to occur as a result of future oil development operations. These mean numbers are published in Ji et al. (2002). **Table 4-30** provides the number of offshore spills ≥1,000 bbl and ≥10,000 bbl that MMS projects based on these estimated mean numbers (the assumed number is the rounded mean) by source and for each planning area, as well as the Gulfwide OCS Program. The assumed number of spills ≥1,000 bbl that could happen from future Gulfwide OCS Program operations during a period is estimated to be between 23 and 33 spills; the number of spills ≥10,000 bbl for the Gulfwide OCS Program is assumed to be between 6 and 9 spills. Based on these probabilities and the mean estimate, MMS assumes that between 0 and 1 spill ≥1,000 bbl is likely to occur in the EPA from all OCS operations in the next 40 years.

The number of possible spills ≥1,000 bbl that could occur shows a widespread frequency distribution. This is a Poisson distribution, which is commonly used for modeling systems in which the probability of an event occurring is very low and random. **Figures 4-7, 4-8, and 4-9** show that distribution, and the great deal of uncertainty as to the number of OCS spills assumed to occur. If the low resource estimate is realized, the number of possible spills ≥1,000 bbl that could occur Gulfwide ranges from 13 to 35, with a rounded mean number of 23 spills estimated. For the high resource estimate, the number ranges from 21 to 40, with the rounded mean number being 33.

OCS Program Offshore Spills <1,000 bbl

The number of spills that could occur was estimated by MMS for different size categories for the Gulfwide OCS Program, based on rounding the mean number of spills calculated. The following table provides MMS's estimate of the number of spills in each size group for different OCS oil development scenarios:

Size Category	OCS Program – Gulfwide
1 bbl	51,550-74,050
>1 and <50 bbl	1,150-1,650
≥50 and <1,000 bbl	250-350
≥1,000 bbl and <10,000 bbl	17-24
≥10,000 bbl	6-9

Table 4-15 provides these same numbers broken down into annual estimates.

Sources of OCS Offshore Spills

Table 4-30 also distinguishes spill occurrence risk by likely operation or source. Besides spills occurring from facilities and during pipeline transport, offshore spills could occur due to OCS future operations from shuttle tankers transporting OCS crude oil into ports. **Table 4-30** includes the likelihood of a spill from a shuttle tanker accident carrying OCS produced crude oil. The scenario with the highest risk of spill occurrence is the high-case resource estimate for the OCS Program in the CPA, which assumes some shuttle-tanker transport of OCS-produced oil. Under that scenario, there is a 49 percent chance that a spill ≥1,000 bbl and a 21 percent chance of a spill ≥10,000 bbl occurring from an OCS-related shuttle tanker during the analysis period.

Sizes of OCS Offshore Spills

Table 4-15 provides the assumed sizes for different size groups for future OCS spills. These spill sizes are based on average size spills that have occurred in each spill size group (**Table 4-26**). For spills ≥1,000 bbl, the median spill size (4,600 bbl) was used because it better represents a likely spill size rather than the average, which is skewed by a few very large events.

4.3.1.1.2.2. Projections of Coastal Spills from OCS Program Operations

Spills in coastal waters could occur at service bases supporting the OCS oil and gas industry, from the transportation of OCS-produced oil through State offshore waters, or from support vessel operations along navigation channels, rivers, and through coastal bays. The MMS projects that 94 to greater than 99 percent of oil produced as a result of OCS operations would be brought ashore via pipelines to oil pipeline shore bases and transferred via pipeline or barge to GOM coastal refineries. Because oil is commingled during storage at shore bases, this analysis of coastal spills focuses on spills that could occur prior to the oil leaving its initial shoreline facility.

Number of OCS Coastal Spills

The MMS calculates the number of coastal spills that could occur as a result of future OCS operations as a subset of all coastal spills. The MMS does not regulate the operations that could spill oil in the coastal zone and does not maintain a database on these spills. MMS relies on spill data obtained from the USCG Marine Safety Information System database and from State agencies. Since the available databases on coastal spills (USGS and States) do not differentiate between OCS and non-OCS sources, MMS proportions all spills occurring in the GOM coastal area by the volumes of oil handled by all oil-handling operations in the coastal area, including OCS support operations, State oil and gas production, intra-GOM transport, and coastal import/export oil activities (Rainey, 1992). For pipeline spills, a separate percentage is estimated to represent the proportion of the number of known pipeline spills by the two major sources of oil piped – State production and OCS production.

Using this approach, MMS estimates an annual number of probable spills that could occur in coastal waters due to Gulfwide OCS-related mishaps. These numbers are provided in **Table 4-15** for various size groups and for a representative future year. We estimate that about 1 spill ≥1,000 bbl and about 75-100 spills <1,000 bbl are likely to occur each year. The one spill ≥1,000 bbl is assumed to be from a pipeline accident.

Locations of OCS Coastal Spills

Oil and gas support operations are widespread from Texas to Alabama. The risk of spills occurring from these operations that support OCS activities would also be widely distributed in this coastal area, but primarily would be focused in the two areas receiving the largest volume of OCS-generated oil – the Houston/Galveston area of Texas and the deltaic area of Louisiana. Based on an in-house analysis of USCG data on all U.S. coastal spills between 1973 and 2000 (**Chapter 4.3.1.1.1.2**., Past Record of OCS Coastal Spills, and USDOT, CG, 2001a), MMS assumes 32 percent of OCS coastal spills occurring in State offshore waters 0-3 mi from shore, 4 percent in State offshore waters that are 3-12 mi from shore (Texas), and 64 percent in inland waters. Approximately 47 percent of inland spills are estimated to occur in coastal rivers and canals, 18 percent in bays and sounds, and 35 percent in harbors.

Sizes of OCS Coastal Spills

Coastal spill sizes specific to OCS operations are not known. For OCS coastal spills <1,000 bbl, a spill size of 6 bbl is assumed based on USCG data. For OCS coastal spills ≥1,000 bbl, a spill size of 4,200 bbl is assumed based on a composite of the median size of a pipeline spill and a barge spill (Anderson and LaBelle, 2000). These spills were identified as the two most likely sources of OCS-related spills that could occur in coastal waters and be ≥1,000 bbl.

4.3.1.1.2.3. Projections of Offshore Spills from Non-OCS Operations

Most non-OCS offshore spills occur from vessel and barge operations. Transit spills occur from navigation-related accidents such as collisions and groundings. Intrinsic spills are those occurring from accidents associated with the vessel itself, such as leaks from hull cracks, broken seals, and bilge upsets. Transfer spills occur during cargo transfer from accidents such as hose ruptures, overflows, and equipment failures.

Collisions and groundings have occurred very infrequently, less than one per 1,000 trips (USDOT, CG, 1993) and do not usually result in an oil spill. However, these accidents have resulted in the largest spills. The frequency of vessel collisions, and thus associated spills, increases as the proximity to shore increases because of the often-congested waterways in the GOM region.

Most small non-OCS offshore spills occur during the cargo transfer of fuel and crude oil. Lightering of oil (the transfer of crude oil from supertankers to smaller shuttle tankers) is a common occurrence in the GOM. There have been about 3-4 spills per 1,000 lightering transfers, with an average spill size of 3 bbl (USDOT, CG, 1993). Lightering of oil destined for the Pascagoula refinery occurs frequently in the OCS waters offshore Pascagoula, Mississippi, an area proximate to the proposed lease sale area. However, lightering is not restricted to this area for double-hulled vessels and could occur anywhere within the GOM.

Number of Non-OCS Offshore Spills

Table 4-15 provides MMS's projections of spills that could occur offshore from non-OCS sources for a typical future year. All offshore spills ≥1,000 bbl not related to OCS operations are assumed to occur from the extensive maritime barging and tankering operations that occur in offshore waters of the GOM. The analysis of spills from tankers and barges ≥1,000 bbl is based on an analysis of numbers of spills that occur annually from different modes of transportation of oil within the GOM region (Rainey, 1992). A total of 3-4 spills ≥1,000 bbl is assumed to occur for a typical future year from the extensive tanker and barge operations.

The estimate for spills <1,000 bbl that occur annually offshore and are not related to OCS operations was obtained from the Marine Safety Office, Pollution Response Department of the 8th USCG District (USDOT, CG, personal communication, 2001b). They estimated this number to be 200-250 spills <1,000 bbl occurring offshore annually from all non-OCS sources.

Sizes of Non-OCS Offshore Spills

Spill sizes for the spills assumed ≥1,000 bbl are derived from median spill sizes for each source, found in Anderson and LaBelle (2000). The average spill size of 6 bbl for spills <1,000 bbl was derived by an analysis of USCG data.

4.3.1.1.2.4. Projections of Coastal Spills from Non-OCS Operations

Coastal spills primarily occur from vessel accidents. Vessel accidents can spill oil from the tanks of import/export tankers while at ports or in bays and harbors; from the cargo tanks of barges and tank vessels that transport crude oil and petroleum products along channels, bayous, rivers, and especially while traversing the GIWW; and from fuel tanks of all other types of vessels, such as recreational boats or grain tankers. Other sources include spills during pipeline transport of petroleum products; crude oil; State oil and gas facilities; petrochemical refinery accidents; and from storage tanks at terminals.

Number of Non-OCS Coastal Spills

The same analytical approach used to estimate OCS coastal spills was used to estimate non-OCS coastal spills. These projections are included in **Table 4-15**. The USCG estimates that about 5-6 spills per 1,000 transfers of oil at ports and terminals (USDOT, CG, 1993).

Locations of Non-OCS Coastal Spills

Based on an MMS analysis of U.S. spill data maintained by the USCG (USDOT, CG, 2001a), the percentages of coastal spill occurrences in different waterbody types are expected to be as follows: 47 percent in rivers and canals; 18 percent in bays and sounds; and 35 percent in harbors. The probable locations can also be broken down by relative location to Federal waters: 32 percent of all coastal spills occur in State offshore waters 0-3 mi from shore; 4 percent occur in State offshore waters 3-12 mi from shore; and 64 percent occur in inland waters.

The majority of spills ≥1,000 bbl is expected to occur near terminals and in association with coastal barging operations of petroleum products (Rainey, 1992). For coastal spills <1,000 bbl, most are expected to occur most frequently during transfer operations.

Sizes of Non-OCS Coastal Spills

The MMS estimated the likely spill sizes for spills occurring in the coastal zone from all non-OCS sources. For spills ≥1,000 bbl, the median spill size for tankers in-port and the median spill size for barges carrying petroleum products was used, based on an MMS published analysis of spill data (Anderson and LaBelle, 2000). For spills <1,000 bbl estimated to occur, MMS analyzed the USCG data on all U.S. spills <50,000 gallons (1,190 bbl) and determined the average size spill for this category was 6 bbl. For spills during transfer operations at terminals, the average size is expected to be 18 bbl (USDOT, CG, 1993).

4.3.1.1.3. Characteristics of OCS Oil

The physical and chemical properties of oil greatly affect how it would behave on the water surface (surface spills) or in the water column (subsea spills), the persistence of the slick on the water, the type and speed of weathering process, the degree and mechanisms of toxicity, the effectiveness of containment and recovery equipment, and the ultimate fate of the spill residues. Crude oils are a mixture of hundreds of different compounds. Hydrocarbons account for up to 98 percent of the total composition. The chemical composition of crude oil can vary significantly from different producing areas; thus, the exact composition of oil being produced in OCS waters varies throughout the GOM. Information on what MMS believes is the likely characteristics of the crude oil that would be produced as a result of a lease sale in the EPA is found in **Chapter 4.3.1.2.1.9.**, Oil Types.

Data on the API gravities of existing reserves (Lore et al., 1999) were reviewed (Trudel et al., 2001). The API gravity is a measurement of the density of the oil. Weighting the gravities by the relative oil production, all of the oils displayed API gravities in the 32-36° range, with an average of 33.9°. This represents a fairly light crude oil. Sorting the data by water depth indicates that oils become slightly heavier as water depths increase.

Water Depth	API Gravity
0-60 m	35°
61-200 m	34°
201-900 m	32°
>900 m	30°

Besides crude oil that is produced on the OCS, accidents can occur which spill other types of petroleum hydrocarbons. Most of these spills have been small. Analysis of the 24 offshore oil spills >50 bbl and <1,000 bbl that occurred between 1985 and 1999 showed that 42 percent were diesel spills, 25 percent were condensate spills, and 21 percent were crude oil spills. The remaining spills were hydraulic fluids (2 spills) and diesel fuel or mineral oil-based drilling muds (2 spills). There has been one diesel spill ≥1,000 bbl (**Table 4-27**).

4.3.1.1.4. Spill Prevention Initiatives

The MMS has comprehensive pollution prevention requirements to guard against accidental spills. This regulatory framework is summarized in **Chapter 1.3.** Improvements in MMS operational requirements, ongoing efforts by the oil and gas industry to enhance safety and pollution prevention, and the evolution and improvement of offshore technology since 1980 have been successful in reducing the total volume of oil spilled from OCS operations. There has been an 89 percent decline in the volume of oil spilled per billion barrels produced from OCS operations from 1980 through the present (8,211 bbl/BBO from facilities and 1,493 bbl/BBO from pipelines) compared to the total volume spilled per billion barrels prior to 1980 (45,897 bbl/BBO from facilities and 44,779 bbl/BBO from pipelines).

Pollution prevention is addressed through proper design and requirements for safety devices to prevent continued flow from a well should a rupture in one of the pipelines or risers occur. Redundancy is provided for critical safety devices that would shut off flow from the well if, for example, a riser were to rupture. Wells, particularly subsea wells, include a number of sensors that help in detecting pressures and the potential for leaks in the production system. Safety devices are monitored and tested frequently to ensure their operation should an incident occur. Barriers are monitored to provide early warning of potential for loss containment. Contingency plans for dealing with a spill are addressed as part of the project-specific OCS development plan, which also requires MMS review and approval before development begins. Operators are required to install curbs, gutters, drip pans, and drains on platform and rig deck areas in a manner necessary to collect all contaminants and debris not authorized for discharge.

4.3.1.1.5. Spill-Response Capabilities

To ensure that industry maintains effective oil-spill response capabilities, MMS

- requires immediate notification to both the USCG and MMS for spills >1 bbl,
- conducts investigations to determine the cause of a spill,
- makes recommendations on how to prevent similar spills,
- assesses civil and criminal penalties if needed,
- oversees spill source control and abatement operations by industry,
- sets requirements and reviews and approves oil-spill response plans for offshore facilities,
- conducts unannounced drills to ensure compliance with oil-spill response plans,
- requires operators to train their staff in spill response,
- conducts inspections of oil-spill response equipment,
- requires industry to show financial responsibility to respond to possible spills, and
- manages oil-spill research on technology and related topics.

4.3.1.1.5.1. Oil-Spill Response Plans

The MMS regulations (30 CFR 254) require that all owners and operators of oil handling, storage, or transportation facilities located seaward of the coastline submit an OSRP for approval. The regulation at 30 CFR 254.2 requires that an OSRP must be submitted and approved before an operator can use a facility, or the operator must certify in writing to MMS that it is capable of responding to a "worst-case" spill or the substantial threat of such a spill. The facility must be operated in compliance with the approved OSRP or MMS-accepted "worst-case" spill certification. Owners or operators of offshore pipelines are required to submit an OSRP for any pipeline that carries oil, condensate, or gas with condensate; pipelines carrying essentially dry gas do not require an OSRP. The OSRP describes how an operator intends to respond to an oil spill. The OSRP may be site-specific or regional. The Emergency Response Action Plan within the OSRP outlines the availability of spill containment and cleanup equipment and trained personnel. It must ensure that full-response capability can be deployed during an oil-spill incident. The OSRP includes an inventory of appropriate equipment and materials, their availability, and the time needed for deployment. All MMS-approved OSRP's must be reviewed at least every two years and all resulting modifications must be submitted to MMS within 15 days whenever

(1) a change occurs that appreciably reduces an owner/operator's response capabilities;
(2) a substantial change occurs in the worst-case discharge scenario or in the type of oil being handled, stored, or transported at the facility;
(3) there is a change in the name(s) or capabilities of the oil-spill removal organizations cited in the OSRP; or
(4) there is a change in the applicable Area Contingency Plans.

4.3.1.1.5.2. Financial Responsibility

The responsible party for every covered offshore facility must demonstrate OSFR as required by OPA 90 (30 CFR 253). A covered offshore facility is any structure and all of its components, equipment, pipeline, or device (other than a vessel or other than a pipeline or deepwater port licensed under the

Deepwater Port Act of 1974) used for exploring, drilling, or producing oil, or for transporting oil from such facilities. The MMS ensures that each responsible party has sufficient funds for removal costs and damages resulting from the accidental release of liquid hydrocarbons into the environment for which the responsible party is liable.

4.3.1.1.5.3. Offshore Response and Cleanup Technology

A number of cleanup techniques are available for response to an oil spill. Open-water response options include mechanical recovery, chemical dispersion, in-situ burning, or natural dispersion. Although bioremediation was at one time considered for use in open water, studies have shown that this technique is not an effective spill-response option in open water because of the high degree of dilution of the product and the rapid movement of oil in open water. Effective use of bioremediation requires that the products remain in contact with the oil for extended periods of time.

Single or multiple spill-response cleanup techniques may be used in abating a spill. The cleanup technique chosen for a spill response would vary depending upon the unique aspects of each situation. The selected mix of countermeasures would depend upon the shoreline and natural resources that may be impacted; the size, location, and type of oil spilled; weather; and other variables. The overall objective of on-water recovery is to minimize the risk of impact by preventing the spread of free-floating oil. The physical and chemical properties of crude oil can greatly affect the effectiveness of containment and recovery equipment, dispersant application, and *in-situ* burning.

Mechanical Cleanup

Generally, mechanical containment and recovery is the primary oil-spill-response method used (33 CFR 153.305(a)). Mechanical recovery is the process of using booms and skimmers to pick up oil from the water surface. In a typical offshore oil-spill scenario, a boom is deployed in a V, J, or U configuration to gather and concentrate oil on the surface of the water. The oil is gathered in the wide end of the boom (front) and travels backward toward the narrow apex of the boom (back). The skimmer is positioned at the apex of the boom, where the oil is the thickest. The skimmer recovers the oil by sucking in the top layer via a weir skimmer, or the oil adheres to and is removed from a moving surface (i.e., an oleophylic skimmer). The oil is then pumped from the skimmer to temporary storage on an attendant vessel or barge, the latter of which serves as the skimming platform. When this on-board storage is full, the oil must be pumped into a larger storage vessel.

Mechanical oil-spill response equipment that is contractually available to the operators through Oil Spill Removal Organization (OSRO) membership or contracts would be called out to respond to an offshore spill in the proposed lease sale area. Each individual operator's response to a spill would differ according to the location of the spill, the volume and source of the spill, the OSRO under contract, etc. At this time, in the GOM, there are three major OSRO's that can respond to spills in the open ocean: (1) Clean Gulf Associates, (2) Marine Spill Response Corporation (MSRC), and (3) National Response Corporation. The equipment owned by these OSRO's is strategically located near the busier port areas throughout the GOM to service the oil and gas exploration and production operators and, in some cases, the marine transportation industry. Numerous smaller OSRO's that stockpile additional shoreline and nearshore response equipment are also located throughout the GOM coastal area.

In consideration of the present location of the major OSRO equipment stockpiles, it is expected that the oil-spill response equipment needed to respond to an offshore spill in the proposed lease sale area would first be called out of Fort Jackson, Louisiana; Venice, Louisiana; Pascagoula, Mississippi; or Mobile, Alabama. Additional equipment, if needed, can be called out from one or more of the following major oil-spill equipment base locations: Corpus Christi, Ingleside, Port Arthur, and Galveston, Texas; Lake Charles, New Iberia, Houma, Fourchon, Fort Jackson, and Venice, Louisiana; or Tampa, Florida. Response times for any of this equipment would vary, dependent on the location of the equipment, the staging area, and the spill site; and on the transport requirements for the type of equipment procured.

It is assumed that 10-30 percent of an oil spill in an offshore environment can be mechanically removed from the water prior to the spill making landfall (U.S. Congress, Office of Technology Assessment, 1990).

Should an oil spill occur during a storm, spill response from shore would occur following the storm. Spill response would not be possible while storm conditions continued, given the sea state limitations for skimming vessels and containment boom deployment. However, oil released onto the ocean surface during a storm event would be subject to accelerated rates of weathering and dissolution (i.e., oil and water would be agitated, forcing oil into smaller droplets and facilitating dissolution of the high end aromatic compounds present).

Dispersants

When dispersants are applied to spilled crude oil, the surface tension of the oil is reduced. This allows normal wind and wave action to break the oil into tiny droplets, which are dispersed into the upper portion of the water column. Natural processes then break down these droplets much quicker than they would if the oil were allowed to remain on the water surface.

Dispersants use must be in accordance with the Regional Response Teams' Preapproved Dispersant Use Manual. Consequently, dispersant use would be in accordance with the restrictions for specific water depths or distances from shore. For a deepwater (>1,000 ft water depth) spill ≥1,000 bbl, dispersant application may be a preferred response in the open-water environment to prevent oil from reaching a coastal area, in addition to mechanical response.

Based on the present location of dispersant stockpiles and dispersant application equipment in the GOM, it is expected that the dispersants and dispersant application aircraft initially called out for an oil-spill response to an offshore spill in the proposed lease sale area would come from Houma, Louisiana. Response times for this equipment would vary, depending on the spill site and on the transport time for additional supplies of dispersants to arrive at a staging location.

In-situ Burning

In-situ burning is an oil-spill cleanup technique that involves the controlled burning of the oil at or near a spill site. The use of this spill-response technique can provide the potential for the removal of large amounts of oil over an extensive area in less time than other techniques. *In-situ* burning involves the same oil collection process used in mechanical recovery, except instead of going into a skimmer, the oil is funneled into a fire-boom, a specialized boom that has been constructed to withstand the high temperatures from burning oil. Fire resistant booms are used to isolate the oil from the source of the slick. The oil in the fire-boom is then ignited and allowed to burn. While *in-situ* burning is another method for disposing of oil that has been collected in a boom, this method is typically more effective than skimmers when the oil is highly concentrated.

For oil to ignite on water, it must be at least 2-3 mm thick. Most oils must be contained with fireproof boom to maintain this thickness. Oils burn at a rate of 3-4 mm per minute. Most oils would burn, although emulsions may require treatment before they would burn. Water in the oil would affect the burn rate; however, recent research has indicated that this effect would be marginal. One approximately 200-m length of fire resistant boom can contain up to 11,000 gallons of oil, which takes about 45 minutes to burn. In total, it would take about three hours to collect this amount of oil, tow it away from a slick, and burn it (Fingas, 2001). Response times for bringing a fire-resistant boom onsite would vary, dependent on the location of the equipment, the staging area, and the spill site.

Natural Dispersion

In some instances, the best response to a spill may be to allow the natural dispersion of a slick to occur. Natural dispersion may be a preferred option for smaller spills of lighter nonpersistent oils and condensates that form slicks that are too thin to be removed by conventional methods and that are expected to dissipate rapidly, particularly if there are no identified potential impacts to offshore resources and a potential for shoreline impact is not indicated. In addition, natural dispersion may also be a preferred option in some nearshore environments when the potential damage caused by a cleanup effort could cause more damage than the spill itself.

4.3.1.1.5.4. Onshore Response and Cleanup Technology

Offshore response and cleanup is preferable to shoreline cleanup; however, if an oil slick reaches the coastline it is expected that the specific shoreline cleanup countermeasures identified and prioritized in the appropriate ACP's for various habitat types would be used. The sensitivity of the contaminated shoreline is the most important factor in the development of cleanup recommendations. Shorelines of low productivity and biomass can withstand more intrusive cleanup methods such as pressure washing. Shorelines of high productivity and biomass are very sensitive to intrusive cleanup methods, and in many cases, the cleanup is more damaging than allowing natural recovery.

Oil-spill response planning in the United States is accomplished through a mandated set of interrelated plans. The ACP represents the third tier of the National Response Planning System and was mandated by OPA 90. The ACP's cover subregional geographic areas. The ACP's are a focal point of response planning, providing detailed information on response procedures, priorities, and appropriate countermeasures. Seven ACP's cover the GOM coastal area. The ACP's are written and maintained by Area Committees assembled from Federal, State, and local governmental agencies that have pollution response authority; nongovernmental participants may attend meetings and provide input. The coastal Area Committees are chaired by respective Federal On-Scene Coordinators from the appropriate USCG Marine Safety Office and are comprised of members from local or area-specific jurisdictions. Response procedures identified within an ACP reflect the priorities and procedures agreed to by members of the Area Committees.

The single most frequently recommended spill-response strategy for the areas identified for protection in all of the applicable ACP's is the use of a shoreline boom to deflect oil away from coastal resources such as seagrass beds, marinas, resting areas for migratory birds, bird and turtle nesting areas, etc. If a shoreline is oiled, the selection of the type of shoreline remediation to be used would depend on the following: (1) the type and amount of oil on the shore; (2) the nature of the affected coastline; (3) the depth of oil penetration into the sediments; (4) the accessibility and the ability of vehicles to travel along the shoreline; (5) the possible ecological damage of the treatment to the shoreline environment; (6) weather conditions; (7) the current state of the oil; and (8) political considerations.

4.3.1.1.5.5. Shoreline Cleanup Countermeasures

The following assumptions regarding the cleanup of spills that contact coastal resources in the area of consideration were determined based upon the guidance ACP's for the coastal areas closest to the proposed lease sale area. Differences in the response priorities and procedures among the various ACP's applicable to the GOM reflect the differences in the identified resources needing spill protection in the area covered by each ACP.

Barrier Island/Fine Sand Beaches Cleanup

After the oiling of a barrier island/fine sand beach with a medium-weight oil, applicable cleanup options are manual removal, trenching (recovery wells), sediment removal, cold-water deluge flooding, shore removal/replacement, and warm-water washing. Other possible shoreline countermeasures include low-pressure cold-water washing, burning, and nutrient enhancement. Responders are requested to avoid the following countermeasures: no action; passive collection (sorbents); high-pressure, cold-water washing; hot-water washing; slurry sand blasting; vacuum; and vegetation cutting.

Fresh or Salt Marsh Cleanup

In all cases, cleanup options that avoid causing additional damage to the marshes would be selected. If a fresh or salt marsh becomes oiled with a medium-weight oil, the preferred cleanup option would be to take no action. Another applicable alternative would be trenching (recovery wells). Shore removal/replacement, vegetation cutting, or nutrient enhancement could be used. The option of using vegetation cutting as a shoreline countermeasure would depend upon the time of the year and would be considered generally only if re-oiling of birds is possible. Chemical treatment, burning, and bacterial addition are potential countermeasures under regulatory consideration. Responders are advised to avoid manual removal; passive collection; debris removal/heavy equipment; sediment removal; cold-water flooding; high- or low-pressure, cold-water washing; warm-water washing; hot-water washing; slurry sand blasting; and shore removal/replacement.

Coarse Sand/Gravel Beaches Cleanup

If a coarse sand/gravel beach becomes oiled with a medium-weight oil applicable cleanup options include manual removal, trenching (recovery wells), sediment removal, cold-water deluge flooding, and shore removal/replacement. Other possible shoreline countermeasures include low-pressure, cold-water washing; burning; warm-water washing; and nutrient enhancement. Responders are requested to avoid the following countermeasures: no action; passive collection (sorbents); high-pressure, cold-water washing; hot-water washing; slurry sand blasting; vacuum; and vegetation cutting.

Exposed or Sheltered Tidal Flats Cleanup

If exposed or sheltered tidal flat becomes oiled with a medium-weight oil, the preferred cleanup option is no action. Other applicable shoreline countermeasures for this resource include trenching (recovery wells) and cold-water deluge flooding. Other possible shoreline countermeasures include low-pressure, cold-water washing; vacuum; vegetation cutting; and nutrient enhancement. Responders are requested to avoid manual removal; passive collection; debris removal/heavy equipment; sediment removal; high-pressure, cold-water washing; warm-water washing; hot-water washing; slurry sand blasting; and shore removal replacement.

Seawall/Pier Cleanup

If a seawall or pier becomes oiled with a medium-weight oil, cleanup options include manual removal; cold-water flooding; low- and high-pressure, cold-water washing; warm-water washing; hot-water washing; slurry sand blasting; vacuum; and shore removal replacement. Other possible shoreline countermeasures include burning and nutrient enhancement. Responders are requested to avoid no action, passive collection (sorbents), trenching, sediment removal, and vegetation cutting.

4.3.1.2. Risk Characterization for Proposed Action Spills

Chapter 4.3.1.1. provided background information and statistics for past and future oil spills in the GOM. This section builds on that information and statistics and presents spill assumptions and scenarios for assessing risks associated with a proposed action.

Risk is defined as a probability of undesired effect, or the relationship between the magnitude of the effect and its probability of occurrence (Suter, 1993). For oil spills, the risk, or the probability of a spill resulting in harmful effects (Suter, 1993) is dependent upon the magnitude, frequency, routes of exposure, and duration of exposure to oil. The purpose of the following risk characterization is to provide a framework or set of assumptions on how much, how often, where, and when spilled oil can occur as a result of a proposed action. This framework or scenario can be used to infer or project (but not to predict or forecast) the most probable routes of exposure to oil and to determine what the chances are of harmful exposure to oil for a resource.

The MMS collects and evaluates data on past spills, along with using results from quantitative models, to characterize the risk from spill events that could occur from a proposed action. Estimates are made about the following that are pertinent to a proposed action: likely spill sources; likely spill sizes; the likelihood and frequency of occurrence for different size spills; timeframes for the persistence of spilled oil; volumes of oil lost from a floating slick due to weathering and cleanup; the likelihood of slick transport by wind and waves resulting in contact to specified environmental features; and the volume of oil dispersed into the atmosphere, water column, and sediments. These components provide the major framework for the exposure and effects assessment addressed in the analyses for the specific resources of concern (**Chapter 4.4.**, Environmental and Socioeconomic Impacts – Accidental Events).

4.3.1.2.1. Frequency, Magnitude, and Source of Spilled Oil from a Proposed Action

4.3.1.2.1.1. Mean Estimated Numbers of Offshore Spills from a Proposed Action

To estimate the mean number of spills that are likely to result from a proposed action, MMS multiplies spill rates based on past records (**Chapter 4.3.1.1.1.**, Past Spill Incidents) times the range of oil resources estimated to be developed as a result of a proposed action. A discussion of how the range of resource estimates was developed is provided in **Chapter 4.1.1.1.1.**, Proposed Action.

The statistical mean number of offshore spills calculated to occur, as a result of the production and transportation of oil during the analysis period associated with a proposed action are provided below:

Spill Size Group	Mean Number of Offshore Spills	
	Low	High
≤1 bbl	218.23	285.37
>1 and <10 bbl	48.56	63.50
≥10 and <50 bbl	1.05	1.38
≥50 and <500 bbl	0.41	0.54
≥500 and <1,000 bbl	0.03	0.04
≥1,000 bbl	0.10	0.13

The mean number of spills for all size categories reflects the fact that, as spill size increases, the occurrence rate decreases and the number of spills estimated to occur decreases. The mean number of spills ≥1,000 bbl estimated for a proposed action is 0.10 to 0.13.

4.3.1.2.1.2. Most Likely Number of Offshore Spill Events for a Proposed Action

Based on the mean number estimated, MMS makes assumptions about the most likely number of offshore spills occurring. The most probable number of offshore spills attributable to a proposed action is provided in **Table 4-31**. These projections are made by rounding the mean number, a statistical estimate, to a whole number. Since mean numbers can include a statistical likelihood of having a partial spill, MMS calculates the most likely number of spills and the statistical likelihood of one or more spills occurring. The MMS assumes that 220-290 spills ≤1 bbl; 50-60 spills >1 bbl and <10 bbl; 1 spill between 10 and 50 bbl, and 1 spill between 50 and 500 bbl are the likely numbers of spills occurring offshore over the 37 year life of a proposed action. For larger spills, even if the high case oil resources are developed, no spills are likely to occur as a result of a proposed action; i.e., the most likely number being zero (<0.5).

4.3.1.2.1.3. Most Likely Number of Coastal Spill Events for a Proposed Action

The MMS uses the USCG Marine Safety Information System database (USDOT, USCG, 2001a) to estimate the number of coastal oil spills attributable to a proposed action. Spills occurring in the GOM coastal area are proportioned by the volumes of oil handled for all oil-handling operations in the coastal area including OCS support operations, State oil and gas production, intra-GOM transport, and coastal import/export oil activities.

Table 4-32 provides the number of spills by size group estimated to occur in coastal waters (both offshore State waters and inland coastal waters) during the analysis period as a result of a proposed action. The MMS estimates that a total of 12-16 spills into GOM coastal waters are likely as a result of a proposed action. Of these spills, 10-12 are assumed to be ≤1 bbl and 3 >1 bbl and <50 bbl. No spills ≥50 bbl are assumed to occur in coastal waters as a result of support activities.

4.3.1.2.1.4. Probability of Spills Occurring as a Result of a Proposed Action

The probability of oil spills occurring assumes that spills occur independently of each other as a Poisson process. The Poisson process is a statistical distribution commonly used to model random events (Smith et al., 1982; Ji et al., 2002). The Poisson process can be used to calculate the likelihood of any number of spills. The results of these calculations are found in **Table 4-31**. For spills ≥l,000 bbl, the probability of one, two, three, four, or five spills occurring is provided in **Table 4-33**.

The MMS calculated the probability of "a" spill occurring (i.e., one or more spills) as a result of a proposed action sometime during its lifetime. There is a 99 percent chance of one or more spills >10 bbl occurring as a result of a proposed action, a 65-75 percent chance of a spill between 10 and 50 bbl, a 34-

42 percent chance a spill between 50 and 500 bbl, a 3-4 percent chance a spill between 500 and 1,000 bbl, and a 9-12 percent chance of a spill ≥1,000 bbl occurring sometime during the life of a proposed action.

The MMS also calculated the probability of the assumed number of spills occurring (the rounded mean). There is a 5-6 percent chance of 50-60 spills >1 bbl and <10 bbl occurring, a 35-37 percent chance of 1 spill between 10 and 50 bbl occurring, a 66 percent chance of zero spills between 50 and 500 bbl occurring, a 31 percent chance of 1 spill between 50 and 500 bbl occurring, a 96-97 percent chance of zero spills between 500 and 1,000 bbl occurring, and a 88-91 percent chance of zero spills ≥1,000 bbl occurring.

4.3.1.2.1.5. Most Likely Sizes of Spills from a Proposed Action

Table 4-31 provides the spill sizes that MMS estimates to be the most likely size that could occur offshore as a result of a proposed action. These spill sizes are based on the average size of past spills for each spill size group (**Table 4-26**).

For spills ≥1,000 bbl, the historic median spill size was used because it better represents a likely spill size rather than the average, which is skewed by a few events. The median size of spills ≥1,000 bbl that occurred during 1985-1999 is 4,551 bbl. Therefore, MMS assumes that the most likely size of a spill ≥1,000 bbl from a proposed action is 4,600 bbl.

Table 4-32 provides an assumed spill size, derived from the USCG statistics, for each of the size categories, for probable spills that could occur in coastal waters as a result of a proposed action. Ten to 12 spills are assumed to be 1 bbl and 3 spills are assumed to be 4 bbl. No larger spills are assumed.

4.3.1.2.1.6. Most Likely Source/Cause of Offshore Spills

An offshore spill from a proposed action could occur if there were an accident on the two projected production facilities or on the drillships while drilling the projected 30-40 wells, from a well blowout, or if there were a break or leak in associated pipelines.

Records show that about 72 percent of spills <1,000 bbl have occurred from mishaps during drilling and production. The kinds of accidents that could result in spills <1,000 bbl are expected to be similar to the causes of past accidents and include storage tank overfills, disconnected flow lines, processing equipment failures, etc. on facilities. The most frequently spilled oil has been diesel used to operate the facilities, not the crude oil being produced.

The MMS believes that the numbers of spills <1,000 bbl estimated (total about 270-350) are high for the level of activity projected (2 production facilities and 30-40 wells). The use of past records of spills on the shelf to predict a rate of spills per BBO produced or handled may lead to overestimates of spills when applied to deepwater operations. This number of spills has never occurred at an individual production site. The MMS continues to evaluate how it derives spill rates and possible differences between shelf and slope spill risks.

Blowouts that could occur from the drilling of wells (**Chapter 4.3.2.**) are often equated with catastrophic spills; however, in actuality very few blowout events have resulted in spilled oil, and the volumes spilled are often very small. Since 1998, four blowouts have resulted in oil spills with the amount of oil spilled ranging from <1 bbl to 200 bbl. **Table 4-27** shows that there have been no spills ≥1,000 bbl from blowouts in the last 30 years.

The probability of a spill ≥1,000 bbl occurring from a facility versus a pipeline accident is calculated by multiplying each source's spill rates by the volume of oil that would be produced or transported and applying the Poisson Process to this analysis. The results of these calculations for spills ≥1,000 bbl are shown in **Table 4-33**. **Table 4-33** indicates that the chance of a spill ≥1,000 bbl occurring on a facility (drillship or production facility) is very low to negligible (1% over the life of a proposed action). The analysis shows that the greatest risk of a spill ≥1,000 bbl occurring from a proposed action is from a pipeline break (9-11%). Causes of pipeline spills ≥1,000 bbl are assumed to be similar to those causes that resulted in past spills of this size since 1985 (shown on **Table 4-28**). Since 1985, all spills ≥1,000 bbl resulted from pipeline breaks caused by hurricanes or anchor and trawl damage. Better designs of offshore facilities have prevented accidents on platforms resulting from the same hurricanes that damaged the pipelines; prior to 1980, hurricane damage was the greatest cause of facility spills ≥1,000 bbl.

The risk of spills from support vessel operations while the vessel is docked at the offshore facility, such as a spill during transfer of diesel fuel, is accounted for in the facility spill estimates. The likelihood of a spill occurring from a service vessel accident offshore while enroute to or from an offshore facility is very low. A review of GOM vessel spills from 1960 to 1995 (size >238 bbl) (OSIR, 1997) was conducted and none of the vessels involved in spills were identified as supply vessels (Etkin, personal communication, 1998).

4.3.1.2.1.7. Most Likely Locations of Probable Offshore Spills

The MMS's reliance on historical records to project future spill occurrence limits our ability to project where a spill occurs, given that there has been no development in the proposed lease sale area. Understanding of the likely development patterns is used to estimate the most likely locations of a spill related to a proposed action.

The MMS knows from past experience that spills <1,000 bbl have primarily occurred at the development site. Therefore, MMS assumes most of the estimated smaller spills (<1,000 bbl) would occur in the proposed lease sale area at the two production sites or at the 30-40 well locations.

For larger spills, MMS uses likely source and the probability of occurrence to estimate the likely location of such a spill. There is a 1 percent chance of a facility spill ≥1,000 bbl occurring in the proposed lease sale area, which would be far from shore, given that the proposed lease sale area is about 70 mi from the Louisiana coast and 100 mi from the Florida coast.

There is a 9-11 percent chance of a spill ≥1,000 bbl occurring somewhere along the two pipeline corridors projected to be used to bring oil from the two offshore facilities to shore. The MMS assumes that, should a pipeline spill occur, it would occur along the portion of the pipeline corridors in the CPA, not in the EPA. This conclusion is based on two facts. First, the water depths in the proposed lease sale area are too deep for typical pipeline accidents to occur, and this makes the likelihood of occurrence much less. Almost all pipeline spills have been the result of an object breaking the line (14 of the 17 pipeline spills ≥1,000 bbl have occurred due to trawl or anchor damage. Second, all of the oil produced from a proposed action is expected to be piped to shorebases in Louisiana for processing (**Chapter 4.1.2.1.5.1.**, Pipeline Shore Facilities). **Figure 4-10** shows the expected pipeline corridors and shows that the portion of the pipeline length within the EPA is much smaller than the portion within the CPA. The MMS estimated the probability of a pipeline spill from a proposed action occurring in the CPA versus the EPA by approximating the distance along the pipeline corridors from the center points of each subarea in the proposed lease sale area to shore. The chance of a pipeline spill ≥1,000 bbl occurring along the portion of pipeline corridors in the EPA would be 25-35 percent (of the 9-11% chance of occurrence), and the chance that a pipeline spill would occur along the portion of the pipeline corridors in the CPA would be 66-75 percent. Multiplying the probability of the spill occurring within the EPA by the probability of it occurring results in a 2-4 percent chance of a pipeline spill ≥1,000 bbl occurring in the EPA.

4.3.1.2.1.8. Most Likely Locations of Probable Coastal Spills

Coastal spills are expected to occur near pipeline terminals or the major service bases. Pipeline terminals where oil produced from a proposed action would come ashore are those located in Louisiana, near Timbalier Bay, Grand Isle, or east of the Mississippi River. The primary service bases are located in Venice and Fourchon, Louisiana, and in Mobile, Alabama.

4.3.1.2.1.9. Oil Types

Crude oil is a complex mixture of thousands of chemical components. The relative concentrations of these components and the physical and chemical properties that result from these mixtures are very important. Information on the characteristics of the oil that could be produced is needed to determine how spilled oil would behave, how long it would persist in the environment, how well it would be able to be cleaned up, and its physical and toxicological effect on biota.

There have been very few samples of oil taken from the oil reservoirs in the proposed lease sale area. The summary of the area's geology (Appendix A.1) provides an overview of the play trends expected to be encountered should exploration and development occur. The MMS reviewed the few available API gravity measurements that were taken during a number of well tests from reservoirs located in CPA deepwater that are associated with plays in the EPA. The API gravities were all below 30°, indicating a fairly heavy crude oil type. It is not expected that this sampling is statistically representative. Two shallower water fields currently in production in the CPA are also considered representative of EPA oil—the Viosca Knoll Block 825 Field (Neptune) and the Viosca Knoll Block 956 Field (Ram-Powell). These oils have a high content of lighter molecular weight compounds.

Based on this information, MMS chose two oils as representative of future production in the proposed lease sale area. Whenever appropriate, this risk analysis makes calculations that incorporate the range of properties of these two oils. An oil from the Neptune Field (Viosca Knoll Block 825, referred to as Neptune Composite Oil) was selected to represent a "light" oil (31° API). A sample of this oil was sent to SINTEF laboratories in Norway under contract to MMS (Schrader and Moldestad, 2001). No GOM oil with comparable analytical data was available to represent a "heavy" oil (28° API). Another oil from the SINTEF database was selected to allow consideration of a heavier oil. This oil was identified as heavy Arabian crude; crude only found in the GOM area because a large volume of it is imported to GOM refineries. This crude oil is likely to contain significant asphaltenes and would therefore persist longer than lighter crudes. Also, it is likely to form a stable emulsion, and it would be more difficult to clean up or disperse. Thus, this oil likely provides an overestimate of oil resistance to weathering.

Within 60 days of commencing production, operators in the proposed lease sale area must provide chemical and physical characteristics of their liquid hydrocarbon production to MMS. This information is available for use in response in the event of a spill.

4.3.1.2.1.10. Estimated Total Volume of Oil from Assumed Spills

The MMS estimates the total volume of oil spilled from coastal spills by multiplying the assumed number of spills by the smallest and largest spill size in each size group sizes. A total of 13 to 162 bbl of oil (rounded to 15 to 160 bbl) is estimated.

The MMS estimates the total volume of oil spilled from offshore spills by multiplying the assumed number of spills by the smallest and largest spill size in each size group. The volume spill rate is the total volume of oil spilled from 1985 to 1999 (46,420 bbl) divided by the total OCS oil production (5.8 BBO), resulting in 0.000008 bbl per bbl of oil produced. Multiplying this rate times the amount of oil production estimated for a proposed action results in an estimated total volume spilled of approximately 500-700 bbl.

Adding both coastal and offshore estimates together results in 515-760 bbl. This volume represents the total loading of oil into GOM waters from assumed, coastal and offshore spill events occurring as a result of a proposed action. The total volume would not be spilled at the same time, but from a number of incidents occurring over the 37-year time period. Experts believe that oil dispersed into the water column has a residence time in GOM waters from a few days up to 6 months (**Chapter 4.3.1.2.2.**, Fate of Spilled Oil).

4.3.1.2.2. Fate of Spilled Oil

Oil is a mixture of different hydrocarbon compounds that begin reacting with the environment immediately upon being spilled. Once spilled, oil begins to spread out on the water surface. A number of processes alter the chemical and physical characteristics of the original hydrocarbon mixture, which results in the original mass spilled being partitioned to the sea surface, the atmosphere, the water column, and the bottom sediments. Weathering, the type and amount of cleanup, and the existing meteorological and oceanographic conditions determine the length of time that the slick remains on the surface of the water, as well as the characteristics of the oil at the time of contact with a particular resource.

The most likely source of a spill ≥1,000 bbl that could occur as a result of a proposed action is a pipeline break. To completely evaluate the fate of such a spill, more information not yet available is needed on the subsurface transport of oil released at the seafloor and how the seafloor release would affect the characteristics of the surface slick. Based on scientific evidence gathered to date, MMS expects that a spill occurring at the seafloor would quickly rise to the surface near the release, initially forming a very thin slick that would cover a surface area larger than if the oil were released at the surface. For purposes of analysis, we assume that the slick would behave similar to modeled surface spills, although it is likely that, because the slick is thinner and spread out more, the slick would likely break up faster than if it were released at the surface.

Given the water depths in the proposed lease sale area and along most of the pipeline corridors, the pipeline spill could occur at the seafloor in deepwater. To learn more about spills released at great depths, MMS has been involved in the study of the fate and behavior of spills in deepwater. In 1998, MMS organized the Deep Spills Task Force, a cooperative research effort between industry and government (Lane and LaBelle, 2000). This task force has completed (1) laboratory experiments to characterize how oil released under pressure would behave, (2) the development of a model that forecast the behavior of oil from a seafloor release, and (3) an experimental release of oil and gas off the coast of Norway in June 2000.

All evidence to date indicates that oil spills that occur at the seafloor from either a blowout or a pipeline break would rise in the water column reaching the sea surface. All known reserves in the GOM OCS to date have specific gravities and chemical characteristics that would result in the oil rising rather than sinking. Data from real spill incidents have shown that the proximity of the surface signature of the spilled oil is dependent upon water column currents and spill characteristics. The *Ixtoc* oil spill in Mexican waters of the GOM had substantial amounts of oil being transported horizontally in the water column as far as 20-30 km from the wellhead (Payne, 1981). An experimental release in Norway showed that the oil released at a depth of 844 m began appearing on the surface about an hour after release within a few hundred meters (horizontally) of the release site (Johansen et al., 2001). Oil continued to surface for several hours after the spill. Evidence from direct observation and remote imagery from space indicates oil slicks originating from natural seeps in the GOM occur on the sea surface almost directly above the known seep locations. Shipboard observations of a natural seep site during submersible operations noted the surface expression of rising oil at a horizontal distance of 100 m from the origin of the seep on the bottom (MacDonald et al., 1995).

4.3.1.2.2.1. Persistence

The persistence of an offshore oil slick is strongly influenced by how rapidly it spreads and weathers and by the effectiveness of oil-spill response in removing the oil from the water surface. As part of the risk analysis of an offshore OCS spill ≥1,000 bbl that could occur from a proposed action, MMS estimated its persistence time; specifically, how long such a spill would last as a cohesive mass on the surface of the water, capable of being tracked and moved by winds and currents. **Figures 4-11 through 4-14** provide a mass balance as a function of time for four scenarios. These scenarios represent the range of environmental conditions, oil types, and release locations determined to be typical of spill events ≥1,000 bbl related to a proposed action. The MMS estimates that a slick formed by such a spill would persist on the water surface between 2 and 30 days, dependent upon the range of conditions. For more information, see the following discussion of the mass balance.

It is expected 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 expected to be diesel, which dissipates very rapidly. Diesel is a distillate of crude oil and does not contain the heavier components that contribute to crude oil's longer persistence in the environment.

4.3.1.2.2.2. Mass Balance of Spilled Oil

The MMS estimated the amount of oil lost from a surface slick as a function of time (a mass balance of spilled oil) for four spill scenarios determined to represent the range of conditions expected of an oil spill event that could occur as a result of a proposed action. **Figures 4-11 through 4-14** summarize the model's results for four scenarios representing two possible oil types, four likely locations, and different environmental conditions possible for a spill event that could occur from a proposed action. An analysis of 16 different scenarios representing every combination of conditions was completed in order to choose the 4 scenarios. These four scenarios represent the minimum and maximum time frames that the slick remained a cohesive mass on the water surface for the range of conditions chosen. Two of the scenarios represent the minimum and maximum volumes of oil remaining in the slick over time for a spill event occurring in the EPA (**Figures 4-11 and 4-12**). Two of the scenarios represent the minimum and maximum volumes of oil remaining in the slick as a function of time for a spill event occurring in the CPA (**Figures 4-13 and 4-14**). **Figure 4-10** shows the locations analyzed.

The results show that, for the four scenarios chosen, a floating slick would be formed from a spill that could occur from a proposed action. A slick formed would dissipate from the sea surface between 48 hours and 30 days; the large range in time reflecting the range of environmental conditions that affect a surface slick, the range of cleanup that could occur, and the range of oil characteristics that could be encountered. The 48-hour period reflects a spill with weathering characteristics of a fairly light oil that does not emulsify (Neptune), a cleanup potential of 50 percent, and constant winds of 7 m/sec (**Figure 4-13**). The 30-day window reflects a spill of a fairly heavy crude that quickly forms stable emulsions inhibiting further weathering, a cleanup potential of 38 percent, and winter conditions reflecting a front that passes early and then winds that die down; this could be considered a worst case (**Figure 4-12**). By 10 days, for the two scenarios where oil still remains on the water surface, approximately 33-37 percent of the slick would be gone from the water surface due to natural weathering and 38-63 percent is expected to have been lost due to man's intervention (mechanical removal and chemical dispersion). These processes are discussed individually below.

The following provides the scenario parameters used for the four scenarios:

- a 4,600-bbl spill of 31° API oil lost over 12 hours as result of a potential pipeline break during summer conditions (30°C) (at DeSoto Canyon Block 884, sustained winds of 5 m/sec (**Figure 4-11**);
- a 4,600-bbl spill of 28° API oil lost over 12 hours as result of a potential pipeline break during winter conditions (12.5°C) at DeSoto Canyon Block 225, wind speeds represent a typical winter storm passage (**Figure 4-12**);
- a 4,600-bbl spill of 31° API oil lost over 12 hours as result of a potential pipeline break during winter conditions (20°C) at mean winds of 7 m/sec (**Figure 4-13**); and
- a 4,600-bbl spill of 28° API oil lost over 12 hours as result of a potential pipeline break during summer conditions (29°C) at Mississippi Canyon Block 952, mean winds of 4 m/sec (**Figure 4-14**).

The SINTEF oil-weathering model was used to numerically model weathering processes. Information on the SINTEF model can be found in Dahling et al. (1997) and Reed et al. (2000). The amounts of oil likely to be mechanically cleaned up and chemically dispersed were also estimated as discussed under "Likely Response/Cleanup of Spill."

4.3.1.2.2.3. Short-Term Fate Processes

Spreading

The two oils chosen as representative of proposed action production would float. In fact, all GOM oils encountered to date float, except under turbulent mixing conditions such as during a large storm offshore. On the sea surface, the oil is expected to rapidly spread out, forming a slick that is initially a few mm in thickness in the center and much thinner around the edges. The rate of spreading depends upon the viscosity of the spilled oil, the oceanographic conditions (wind, wave, and current), whether or not the oil is released at the water surface or subsurface, and whether the spill is instantaneous or continuous.

Spilled oil is expected to continue to spread until its thickest surface layer is about 0.1 mm. Once it spreads thinner than 0.1 mm, the slick would begin to break up into small patches, forming a number of elongated slicks, referred to as windrows, which align in the wind direction. The oil is not spread in a homogeneous layer. The oil film thickness varies, often by a factor of several thousand (Reed et al., 2000). If emulsification occurs (see below), a very small portion of the slick (less than 10% of the total area) would consist of patches of emulsion with a film thickness of 1-5 mm with an even thinner sheen trailing behind each patch of oil (<1 μm in thickness). **Figure 4-15** depicts a typical slick.

Weathering

Chemical, physical, and biological processes operate on spilled oil to change its volume and properties over time, reducing many of the components until the slick can no longer continue as a cohesive mass floating on the surface of the water. **Figure 4-16** illustrates the various weathering processes and **Figure 4-17** shows their relative importance with time. These natural processes are evaporation, water-in-oil emulsification, dissolution, oil-in-water dispersion, sedimentation, oxidation, and biodegradation. The degree that each of these processes affected spilled oil is dependent upon the chemical and physical properties of the oil, the weather conditions (wind, waves, temperature, and sunlight), and the properties of the seawater (salinity, temperature, bacteria, etc.) (Reed et al., 2000).

Evaporation

The evaporation of the light components of oil begins immediately, resulting in changes to the physical properties of the oil remaining on the sea surface. The rate of total mass loss by evaporation increases initially because of the increasing surface area, but decreases as the remaining amount of volatile hydrocarbons are lost. Evaporation is very important because the loss of the volatile hydrocarbons reduces the spilled oil's vapor pressure (a safety concern) and its acute toxicity, while increasing the oil's density and viscosity. The tarry fractions of the oil increase, which may result in tarball formation or stable emulsions (Fingas, 1997). For the four scenarios representative of the range of conditions that would affect a potential spill that could occur from a proposed action, about 30-45 percent of the Neptune Composite oil is likely to evaporate before the slick disperses in 2-3 days (**Figures 4-11 and 4-13**). Between 28 and 31 percent of the heavier crude is likely to evaporate before the slick disperses in 20-30 days (**Figures 4-12 and 4-14**).

Dissolution

Dissolution is not a major process affecting the persistence of a slick; dissolution of no more than a few percent is expected (NRC, 1985). The most soluble hydrocarbons are likely to be preferentially removed by evaporation, which is typically order of magnitude faster. Some components of oil are soluble in seawater; and this is an important route for biological uptake. Usually the more soluble an oil compound is, the more toxic it is. However, solution followed by rapid dilution throughout the water column tends to reduce adverse biological effects. No estimate of the loss of slick area due to this process is made. Omission of this process is not expected to significantly affect the estimate of the oil remaining on the water surface.

Water-in-Oil Emulsification

The formation of water-in-oil emulsions is the most important weathering process controlling the stability of surface slicks and the ability of man to remove oil from the sea surface. Emulsification is extremely dependent upon oil composition. Stable emulsions can last for years (Fingas and Fieldhouse, 1998). Many GOM oils do not form emulsions (Jokuty et al., 1996), which is useful to understand the rapid dispersion and extent of cleanup of surface slicks noted during past spill events (Rainey and Peuler, in preparation).

The oils chosen as representative of proposed action production were tested in the laboratory to determine if they formed emulsions (SINTEF, 2001). The Neptune Field Composite oil does not form stable water in oil emulsions on the sea surface. The heavy Arabian Crude, chosen to represent an upper end of heavy oils that might be developed, does.

4.3.1.2.2.4. Longer-Term Weathering Processes

Figures 4-11 through 4-14 show the estimated time a slick would remain on the surface, if a spill occurred at four locations (2 points along possible pipeline routes and 2 points within the proposed lease sale area). Given a number of conditions, a slick formed from a spill within the proposed lease sale area is estimated to remain floating on the water surface up to 30 days prior to dissipating (**Table 4-36**). A slick, formed from a spill along a possible pipeline route in the CPA, is estimated to remain floating on the water surface up to 20 days.

Most fate modeling tools developed by the scientific community have been designed to predict the fate of oil spills for only a few days in order to answer immediate response questions and because most spills, such as vessel grounding, would reach shore within this timeframe. Recently, MMS organized a workshop to improve the knowledge of long-term weathering processes (USDOC, NOAA and USDOI, MMS, 2002). The workshop was intended to initiate discussions among spill experts about what is known about the persistence and behavior of large open water oil slicks, to assess what is the state of knowledge of existing long-term weathering predictions for such spills, and to prioritize our information needs and research.

Oil-in-Water Dispersion/Mixing of Oil into the Water Column

Once spread out, oil slicks are subjected to the action of waves in the ocean. The waves break off oil globules that are pushed down into the water column. The size of the oil droplet determines the residence times of the oil-in-water dispersion. Large droplets tend to rise up and join with the surface slick again, whereas smaller droplets remain in suspension. Ocean turbulence acts to further disperse the oil-in-water droplets. The amount of the oil submerged in the water column increases with time. Droplet formation, breaking waves dynamics, and open ocean turbulence can be modeled to predict the amount of oil dispersed into the water column (Aravamudan et al., 1981; Reed et al., 2000). The concentration of oil in the water column under a slick varies but usually is less than 1 ppm. If one were to disperse a slick of 0.1-0.01 mm thickness into the water column, the maximum concentration would be 10 ppm if dispersed totally in the top 10 m. Audunson et al. (1984) reports oil concentrations on the order of tens of parts per billion under a experimental spill off Norway.

For the four scenarios representative of the range of conditions that would affect a potential spill that could occur from a proposed action, 8-21 percent of the Neptune Composite could disperse into the water column and 6-21 percent of the heavier crude could disperse into the water column (**Figures 4-11 through 4-14**).

Chemical and Photo-Oxidation

Oil compounds undergo chemical changes due to exposure to the sun. Oxidation can create products that are more toxic and more soluble than their parent compounds. Oxidation can also aid in slick breakup and are considered important in tarball formation.

At present, there are no models available that calculate the loss of slick volume due to this process (USDOC, NOAA and USDOI, MMS, 2002) although some scientists believe that it may play a significant role in changes to a slick after short-term processes diminish. Therefore, our estimate of the slick life for a spill may be an overestimation.

Biodegradation of Oil in the Water Column

The droplets of oil found in the water column as a result of a spill are distributed between soluble and oil droplet phases. The microorganisms in the seawater would rapidly start degrading the water-soluble oil compounds, removing them completely within a few days, generally resulting in reduced toxicity to marine organisms (USDOC, NOAA and USDOI, MMS, 2002). The degradation rates for the dispersed oil droplets are slower and range from 30 days to 6 months.

No estimate of the amount of oil removed from the surface slick area due to this process is made. Currently, there are no models available that calculate the loss of slick volume due to this process (USDOC, NOAA and USDOI, MMS, 2002) although some scientists believe that it may play a significant role in changes to a slick after short-term processes diminish. Therefore, our estimate of the slick life for a spill may be an overestimation.

Sedimentation

Sedimentation is the process where oil particles join particulate matter suspended in the water column, eventually sinking to the ocean bottom. This process was not modeled. It is thought that the long-term fate of spilled oil within the turbid waters of the offshore Mississippi River plume may be highly affected by this process.

Tarry Residues/Tarballs

Over time, if the slick is not completely dissipated, a tar-like residue may be left, and this floating residue breaks up into smaller tar lumps or tarballs. Not all oils form tarballs; many GOM oils do not (Jefferies, 1979). There is not scientific agreement over exactly what constitutes a tarball (USDOC, NOAA and USDOI, MMS, 2002). Most scientists agree that tarballs are floating residues primarily made up of the asphalt fraction of oil. Some believe they are oil that was once stranded on the shore, and some studies have found quantities of plant material, sand, and clay particles contained within tarballs (Payne, 1981). Tarballs range in size from a few mm to 30 cm. Some are quite soft in the middle and begin to flow on the beach due to atmospheric heating, while others are quite hard and brittle.

Most tarballs in the GOM have been identified chemically as being waxy residues from tanker cleaning discharges (Payne, 1981; Overton et al., 1983; USDOC, NOAA, 1979; Henry et al., 1993). Federal regulations now exist that prohibit the discharge of tanker washings.

Both of the oils chosen as representative of oils likely to be produced in the EPA are assumed to form some amount of tarry residues, if spilled. There are no models that estimate the percentage of the spilled oil that becomes tarballs.

4.3.1.2.2.5. Likely Response/Cleanup of Spill

Based on historic information, this EIS analysis assumes that dispersant application would be effective on 20-50 percent (S.L. Ross Environmental Research Ltd., 2000) of the treated oil. The assumptions used in calculating the amounts removed as a result of dispersant use and mechanical recovery efforts for the four 4,600-bbl spill scenarios are listed below:

- All of the spills occurred and were reported at 6 a.m.
- Spill-response efforts were conducted during daylight hours only. A 12-hour operational window was assumed for both the winter and summer season.
- Mechanical response equipment included fast-response units having a USCG de-rated skimming capacity of 3,400 bbl/day owned by the oil-spill-response cooperative, Clean Gulf Associates. This equipment was procured from Ft. Jackson, Louisiana, and Pascagoula, Mississippi, for response to DeSoto Canyon Blocks 884 and 225 and Viosca Knoll Block 948.
- Dispersant application aircraft was deployed from Houma, Louisiana. This location also served as the staging location for loading dispersants. Three aircraft, two DC3's and one DC4, were deployed for dispersant application.
- Sea-state conditions: during the summer—waves were 2 ft; during the winter—waves ranged from 1.3 to 8 ft.
- A dispersant effectiveness rate of 30 percent was assumed for the treated 31° API oil. Based on the weathering of this oil, the initial dispersant effectiveness rate of 30 percent of the treated 28° API oil dropped to 20 percent on day 2 in the DeSoto Canyon Block 225 scenario and on day 3 of the Mississippi Canyon Block 952 scenario (S.L. Ross Environmental Research Ltd., 2000).
- Approximately 10 percent of the 31° API oil and 15 percent of the 28° API oil was mechanically removed. This is based on information that 10-30 percent of a spill in an offshore environment can be mechanically removed from the water prior to the spill making landfall (U.S. Congress, Office of Technology Assessment, 1990) and on the chemical characteristics of the oils used for these scenarios.
- Because of the projected stable emulsion formation of the 28° API, it was assumed that dispersant application would no longer be effective after 48-72 hours in the scenarios involving this oil.

Figures 4-11 through 4-14 provide the estimated amounts of oil that are expected to be removed by the application of dispersants or mechanically recovered for the four 4,600-bbl pipeline spill scenarios analyzed in this EIS. For the possible range of spill conditions estimated for a spill that could occur from a proposed action within the EPA, 23-39 percent of the slick could be chemically dispersed and 9-15 percent mechanically removed. For the possible range of spill conditions estimated for a spill that could occur from a proposed action within the CPA, 23-48 percent of the slick could be chemically dispersed and 15-27 percent can be mechanically removed.

4.3.1.2.3. Direct Exposure/Contact with Locations Where Sensitive Resources May Occur

4.3.1.2.3.1. Transport of Slicks by Winds and Currents

Spills ≥1,000 bbl

The MMS uses a numerical model to calculate the likely trajectory of a surface slick, should a spill occur. A description of the trajectory model, called the OSRA (oil spill risk analysis) model, can be found in a separate report (Ji et al., in preparation), and its results are summarized in this EIS and published in the same report.

The OSRA model simulates thousands of spills launched throughout the GOM OCS and calculates the probability of these spills being transported and contacting specified environmental resources. The probability of a spill being transported and contacting specified resources is then multiplied by the estimated mean number of spills that could be transported (**Chapter 4.3.1.2.1.1.**, Mean Estimated Numbers of Offshore Spills from a Proposed Action). The results are used to estimate the risk of future spills occurring and contacting environmental features. The OSRA results in a numerical expression of risk based on spill rates, projected oil production, and trajectory modeling.

The OSRA model simulates the trajectory of a point launched from locations mapped onto a gridded area. The gridded area represents an area of the GOM and the point's trajectory simulates a spill's movement on the surface of water using modeled ocean current and wind fields. The model uses temporally and spatially varying, numerically computed ocean currents and winds.

The OSRA model can simulate a large number of hypothetical trajectories from each launch point. Spill trajectories are launched once per day from each origin point and are time stepped every hour until a statistically valid number of simulations have been run to characterize the risk of contact. The simulated oil spills for this EIS were "launched" from approximately 4,000 points uniformly distributed 6-7 mi apart within the GOM OCS. This spacing between launch points is sufficient to provide a resolution that creates a statistically valid characterization of the entire area (Price et al., 2001).

The model tabulates the number of times that each trajectory moves across or touches a location (contact) occupied by polygons mapped on the gridded area. These polygons represent locations of various environmental features. The OSRA model compiles the number of contacts to each environmental feature that result from the modeled trajectory simulations from all of the launch points for a specific area. Contact occurs for offshore features if the trajectory simulation passes through the polygon. Contact occurs for land-based features if the trajectory simulation touches the border of the feature. The simulation stops when the trajectory contacts the lines representing the land/water boundary or the borders of the domain. The probability of contact to an environmental feature is calculated by dividing the number of contacts by the number of trajectories started at various launch locations in the gridded area.

The output from this component of the OSRA model provides information on the likely trajectory of a spill by wind and current transport, should one occur and persist for the time modeled in the simulations; the calculations for this EIS were modeled for 30 days.

The analysis of the fate of a possible OCS spill (**Chapter 4.3.1.2.2.**) shows that the slicks likely to be formed would persist on the water surface, capable of being transported by winds and currents, for 2-30 days before dispersing, dependent upon the location, season, and type of oil spilled. Given this range, the OSRA model results used in this risk analysis include two time periods for analysis: (1) the likelihood of contact that could occur within 10 days after a spill occurs and (2) the likelihood of contact that could occur up to 30 days. There are very little records that support that a spill would last for up to 30 days.

Spills <1,000 bbl

As discussed above, to be transported by winds and currents, an oil slick must remain a floating cohesive mass. Based on fate model calculations and what is known about past spills, MMS assumes that spills ≤50 bbl would not persist long enough to be transported a significant distance away from their origin point; however, spills ≥50 bbl and <1,000 bbl would remain a cohesive mass long enough to be transported some distance. The MMS therefore assumes that a slick formed from a spill in this size range could float away from the spill location for up to 3 days by winds and currents prior to dissipating.

4.3.1.2.3.2. Offshore Surface Area Covered by Spilled Oil/Surface Layer Thickness

The surface area covered by a slick as a function of time is dependent upon many complex factors that include the degree of drifting and spreading that the spilled oil has undergone on the water surface, meteorological and oceanographic conditions, and the amount cleaned up and weathered. Soon after a spill occurs, the surface water area reaches a maximum, as the oil rapidly spreads out until the slick becomes spread into a thin rainbow sheen that begins breaking up.

The MMS estimates the thickness and water surface covered by an oil slick formed from a range of conditions for different times after a spill event (≥1,000 bbl). **Tables 4-35 to 4-38** summarize MMS's calculations for four scenarios representing two possible oil types, four likely locations, and different environmental conditions possible for a spill event that could occur from a proposed action. These four scenarios represent the minimum and maximum time frames that the slick remained a cohesive mass on the water surface for the range of conditions chosen. The surface area is estimated using the calculation of the volume of oil remaining in a slick over time (**Figures 4-11 through 4-14**) and the NOAA correlation tables that predict slick area versus volume (http://response.restoration.noaa.gov/oilaids/spiltool/). If an offshore spill ≥1,000 bbl of oil were to occur as a result of a proposed action and typical offshore response was to take place, and dependent on the range of oil characteristics and environmental conditions, the maximum water surface area covered by such a slick would be between 0.20 and 1 mi^{2}.

4.3.1.2.3.3. Likelihood of an Offshore Spill Occurring and Contacting Modeled Locations of Environmental Resources

Spills ≥1,000 bbl

A more complete measure of spill risk was calculated by multiplying the probability of contact generated by the OSRA model by the probability of occurrence of one or more spills ≥1,000 bbl as a result of a proposed action. This provides a risk factor that represents the probability of a spill occurring as a result of a proposed action and contacting the resource of concern. These numbers are often referred to as "combined probabilities" because they combine the risk of occurrence of a spill from OCS sources and the risk of such a spill contacting sensitive environmental resources.

The OSRA results show that there is a risk of <0.5 percent of resources being exposed to a spill resulting from a proposed action. The likelihood of a spill ≥1,000 bbl occurring, transported on the water surface by winds and currents, and reach locations of identified resource habitats, offshore features, or counties and parishes ranges from less than 0.5-5 percent for the resources analyzed. **Figures 4-18 through 4-36** show the locations of the resources analyzed and the range in the combined probabilities of occurrence and contact for two time periods (10 and 30 days) and for two different oil development scenarios (low and high). **Table 4-34** provides a listing of only those resources or parishes where OSRA model analysis resulted in probabilities >0.5 percent and provides the probabilities for these features.

Spills <1,000 bbl

Based on fate model calculations and what is known about past spills, MMS assumes that for a spill >50 bbl and <1,000 bbl would be transported by winds and currents for up to 3 days prior to the slick dissipating.

A review of the transport probabilities showed that, if a spill <1,000 bbl were to occur within the proposed lease sale area, it would not make landfall within 3 days.

Therefore, the only risk of contact from spills <1,000 bbl associated with a proposed action is assumed to be from spills occurring in the CPA along the proposed pipeline corridors, outside of the proposed lease sale area (**Chapter 4.1.1.8.1.**, Pipelines). A review of transport probabilities for these pipeline routes does show a small likelihood that contact could occur within 3 days. Given that there is a 9-11 percent chance of a pipeline spill of a few bbl occurring from a proposed action, the chance of it occurring at a location where landfall would occur would be much less.

4.3.1.2.3.4. Length of Shoreline That Could be Exposed to Stranded Oil if an Offshore Spill Occurring as a Result of a Proposed Action were to Contact Land

An estimate of the maximum shoreline length that would be exposed to spilled oil, should a spill come ashore, is a simple arithmetic calculation based on the estimated surface water area covered (**Chapter 4.3.1.2.3.2.**). The calculation assumes that the slick would be carried 30 m inshore of the shoreline, either onto the beachfront up from the water's edge or into the bays and estuaries, and would be spread out at a uniform thickness of 1 mm; this assumes that no oil-spill boom is used.

For ≥1,000 bbl spills originating within the proposed lease sale area, the OSRA model transport probabilities of contact (an intermediate product in the OSRA model calculations) shows that no oil would make it to shore from the proposed lease sale area prior to 3 days. Therefore, the maximum length of shoreline that would be contacted by a spill occurring within the proposed lease sale area is estimated from the maximum water surface area that was calculated after 3 days. **Tables 4-35 and 4-36** summarize the calculations for the two scenarios representing two possible oil types, two locations within the EPA, and different environmental conditions possible for a spill event that could occur from a proposed action within the EPA. Between 3 and 80 km of shoreline could be exposed to stranded oil, dependent upon the season, wind and wave conditions, and type of oil. There is a 1 percent chance of a platform spill occurring within the EPA, and a 2-4 percent chance of a pipeline spill ≥1,000 bbl occurring in the EPA, calculated by multiplying the risk of occurrence times the risk of location. The risk of these spills occurring and reaching shoreline would be much less. Only spills occurring near Louisiana State waters along the pipeline systems bringing a proposed action oil to Louisiana terminals have a chance of reaching shore prior to 3 days. The maximum length of shoreline contacted by a spill ≥1,000 bbl occurring proximate to the Louisiana shoreline, for the conditions analyzed, is estimated to be 20-70 km of shoreline, assuming a slick were to reach land by 24 hours.

Tables 4-37 and 4-38 summarize MMS's calculations for two scenarios representing two possible oil types, two locations within the CPA, and different environmental conditions possible for a spill event ≥1,000 bbl that could occur from a proposed action anywhere along the pipeline corridors within the CPA. After 3 days, the maximum length of shoreline that could be exposed to stranded oil is estimated to be 10 km, dependent upon the season, wind and wave conditions, and type of oil.

Once oil is beached, some redistribution of the oil due to longshore currents and further smearing of the slick from its original landfall could also occur. It should be noted that these are likely overestimates of shoreline contact that do not include adjustment for the use of diversion booming and other shoreline protection measures.

4.3.2. Blowouts

Improperly balanced well pressures that result in sudden, uncontrolled releases of fluids from a wellbore or wellhead are called blowouts. Blowouts can happen during exploratory drilling, development drilling, production, well completions, or workover operations. One-third of blowouts were associated with shallow gas flows. Most blowouts last for a short duration, with half lasting less than a day.

From 1992 to 2001, a total of 43 blowouts have occurred in the OCS with an average of 4 blowouts per 1,000 well starts. From 1995 to 2001, the blowout rate rose from 1 per 1,000 well starts to 6 per 1,000 well starts. The rate is the same for wells drilled in shallow and deep water. During the last three years there were slightly more blowouts associated with development (6 per 1,000 well starts) than exploration (5 per 1,000 well starts). For this EIS, blowout rates of 7 per 1,000 well starts and 2 per 1,000 existing wells were used.

Blowouts may result in the release of synthetic drilling fluid or loss of oil. From 1992 to 2001, less than 10 percent of the blowouts have resulted in spilled oil. Of the 43 blowouts that have occurred during this period, four resulted in oil release ranging from 0.5 to 200 bbl.

In 1997, an MMS-funded study on the fate and behavior of oil well blowouts (S.L. Ross Environmental Research Ltd., 1997). Oil well blowouts generally involve two fluids—crude oil (or condensate) and natural gas. A highly turbulent zone occurs within a few meters of the discharge point, then rapidly loses momentum with distance. In deepwater (>300 m) with lower temperatures and higher pressures, gas may form hydrates and the volume of gas may be depleted through dissolution into the water. Larger droplets would reach the surface faster and closer to the source, while smaller droplets would be carried farther by the currents before reaching the surface.

Severe subsurface blowouts could resuspend and disperse abundant sediments within a 300-m radius from the blowout site. The fine sediment fraction could be resuspended for more than 30 days. The coarse sediment fraction (sands) would settle at a rapid rate within 400 m from the blowout site, particularly in a 30-m water depth and a 35-cm/sec blowout scenario.

The MMS requires the use of (BOP's and that BOP systems are tested at specific times: (1) when installed, (2) before 14 days have elapsed since the last BOP pressure test, and (3) before "drilling out" each string of casing or a liner (30 CFR 250.407). A 1996 MMS-funded study looked at the reliability of BOP's (Tetrahedron, Inc., 1996). This study found that subsea BOP's had a lower failure rate (28%) than surface BOP's (44%). A test was considered to have failed if any piece of equipment had to be physically repaired or sent for repairs after the test.

An estimated 0-1 blowouts could occur from activities resulting from a proposed action in the CPA. For OCS Program activities in the GOM for the years 2003-2042, the estimated total number of blowouts is 215-259.

4.3.3. Vessel Collisions

The MMS data show that, from 1995 to 2001, there were 56 OCS-related collisions. Most collision mishaps are the result of service vessels colliding with platforms or vessel collisions with pipeline risers. Approximately 10 percent of vessel collisions with platforms in the OCS caused diesel spills. To date, the largest diesel spill associated with a collision occurred in 1979 when an anchor-handling boat collided with a drilling platform in the Main Pass Area, spilling 1,500 bbl.

Safety fairways, traffic separation schemes, and anchorages are the most effective means of preventing vessel collisions with OCS structures. In general, fixed structures such as platforms and drilling rigs are prohibited in fairways. Temporary underwater obstacles, such as anchors and attendant cables or chains attached to floating or semisubmersible drilling rigs, may be placed in a fairway under certain conditions. A limited number of fixed structures may be placed at designated anchorages. The USCG's requirements for indicating the location of fixed structures on nautical charts and for lights, sound-producing devices, and radar reflectors to mark fixed structures and moored objects also help minimize the risk of collisions. In addition, the USCG 8th District's Local Notice to Mariners (monthly editions and weekly supplements) informs GOM users about the addition or removal of drilling rigs and platforms, locations of aids to navigation, and defense operations involving temporary moorings. Marked platforms often become aids to navigation for vessels (particularly fishing boats and vessels supporting offshore oil and gas operations) that operate in areas with high densities of fixed structures.

The National Offshore Safety Advisory Committee (NOSAC) examined collision avoidance measures between a generic deepwater structure and marine vessels in the GOM (NOSAC, 1999). The NOSAC offered three sets of recommendations: (1) voluntary initiatives for offshore operators; (2) joint government/industry cooperation or study; and (3) new or continued USCG action. The NOSAC (1999) proposes that oil and gas facilities be used as aids-to-navigation because of their proximity to fairways, fixed nature, well-lighted decks, and inclusion on navigational charts. Mariners intentionally set and maintain course toward these facilities, essentially maintaining a collision course. Unfortunately, most deepwater facilities do not install collision avoidance radar systems to alert offshore facility personnel of a potentially dangerous situation. The NOSAC estimates that 7,300 large vessels (tankships, freight ships, passenger ships, and military vessels) pass within 35 mi of a typical deepwater facility each year. This estimate resulted in approximately 20 transits per day for the 13 deepwater production structures existing in 1999. The NOSAC found the total collision frequency to be approximately one collision per 250 facility-years (3.6×10^{-3} per year). The NOSAC estimated that if the number of deepwater facilities increases to 25, the estimated total collision frequency would increase to one collision in 10 years. A cost-benefit analysis within the report did not support the use of a dedicated standby vessel for the generic facility; however, the analysis did support the use of a radar system on deepwater facilities if the annual costs of the system were less than or equal to $124,500.

The OCS-related vessels could collide with marine mammals, turtles, and other marine animals during transit. To limit or prevent such collisions, NOAA Fisheries 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.

4.5. CUMULATIVE ENVIRONMENTAL AND SOCIOECONOMIC IMPACTS

4.5.1. Impacts on Air Quality

The northeastern GOM has been subdivided into subareas based on water depth (0-60 m, 60-200 m, 200-800 m, 800-1,600 m, 1,600-2,400 m, and >2,400 m) (**Figure 3-10**). **Table 4-4** presents the numbers of exploration, delineation, and development wells; platforms; and service-vessel trips projected for the cumulative scenario in each offshore subarea in the EPA.

The types of OCS-related emissions sources and their usage are similar for a proposed action and for cumulative OCS Program activities in the EPA. The main differences between these two analyses are that a proposed action analysis considered only the emissions associated with one lease sale and the area analyzed was restricted to a smaller area within the EPA. In the cumulative analysis, the cumulative emissions from existing sources, a proposed lease sale, and potential future lease sales are combined and the area analyzed is the EPA. The OCS Program emissions in the EPA for 2003-2042 are estimated in **Table 4-41** and in the CPA in **Table 4-42**. Total OCS emissions for each EPA subarea for the OCS Program scenario are presented in **Table 4-43** and for each CPA subarea in **Table 4-44**. Pollutants are distributed to subareas proportional to the projected number of production structure installations identified for those areas.

Emission rates for the cumulative scenario are not uniform but do not vary greatly from year to year. The deviation is on the order of 10 percent or less for the entire 40 years. This is in contrast to the distinctive peaks in activities associated with a single lease sale (**Chapter 4.2.1.1.**, Impacts on Air Quality). The small variation in the emission trend is caused by smoothing the overlapped successive peaks from individual lease sales. The peak-year emissions are calculated by combining peak-year activity total emissions for exploratory wells, development wells, and platforms over 40 years, and superimposing peak projected activity for support vessels and other emissions into that peak year. It is important to note that well drilling activities and platform peak-year emissions are not necessarily simultaneous. However, it is assumed for this analysis that total well and platform peak-year emissions combined with vessels and other emissions occur simultaneously. Use of the peak emissions provides the most conservative estimates of potential impacts to onshore air quality. For conservative estimation, it is assumed that emissions from potential oil spills and blowouts also occur in the peak year. Yet, platforms remain the primary source of VOC emissions.

Peak-year emissions for the entire 40 years of EPA activities are presented in **Table 4-45** and CPA activities are presented in **Table 4-46**. The peak year is expected to occur between 2007 and 2016. Peak-year emissions for each subarea for the cumulative EPA scenario are presented in **Table 4-47** and the cumulative CPA scenario is presented in **Table 4-48**. Pollutants are distributed to subareas proportional to the projected number of production structure installations identified for those areas.

The VOC emissions are best addressed as their corresponding ozone impacts, which were studied in the GMAQS. The GMAQS indicated that OCS activities have little impact on ozone exceedance episodes in coastal nonattainment areas. Total OCS contributions to the exceedance (greater than 120 ppb) episodes studied were less than 2 ppb. In the GMAQS, the model was also run using double emissions from OCS petroleum development activities; the resulting attributable ozone concentrations, during modeling exceedance episodes, were still small, ranging 2-4 ppb. The cumulative activities under consideration would not result in a doubling of the emissions, and because they are substantially smaller than this worst-case scenario, it is logical to conclude that their impact would be substantially smaller as well (Systems Applications International et al., 1995).

Estimated emissions from exploratory and development well drilling, production facilities, and service operations are included for NO_x, CO, SO_2, VOC, and PM_{10}. No estimate for ozone levels is made because ozone is a secondary pollutant not directly emitted to the atmosphere by anthropogenic sources. The formation of ozone resulting from OCS operations can be estimated only by advanced photochemical modeling techniques.

Table 4-7 shows gas processing plants and oil pipeline shore facilities related to the OCS Program projected to be constructed between 2003 and 2042. It is assumed that new source performance standards and best available control technology would be used on all onshore facilities and that additional controls or offsets may be required in some areas to meet air quality standards imposed by existing and new regulations.

Blowouts are accidents defined as an uncontrolled flow of fluids from a wellhead or wellbore. The air pollutant emissions from blowouts depend on the amount of oil and gas released, the duration of the accident, and the occurrence or not of fire during the blowout. Because of technological advances, blowout duration has decreased. Also, most blowouts occur without fire (MMS database), and the amount of oil released during these accidents has been small. The total emissions of VOC attributable to blowouts is between 49 and 148 tons during the cumulative scenario, which projects between 0 and 1 blowout from OCS Program activities in the EPA. It must be remembered that these are conservative estimates and that the total amount of VOC may be less.

The MMS studied the impacts of offshore emissions using the OCD Model. Modeling was performed using OCD version 5. Three years of meteorological data (i.e., 1992, 1993, and 1994) were used. Over-water data are from Buoy 42007, onshore meteorology from New Orleans NWS station, and upper air data from the Slidell, Louisiana, radiosonde station. Default values of 500 m for the mixing height and 80 percent for the relative humidity were used for the over-water meteorological data. Receptors were set at Breton Island and along the coastline and also a short distance inland in order to capture coastal fumigation. The receptor at Breton Island (**Figure 3-2**) was chosen to represent the Class I area. Pollutants are distributed over the northeastern GOM. For the Class I and Class II areas (all areas excluding Class I), the calculated concentrations are reported in **Tables 4-49 and 4-50** and are compared with the maximum allowable concentration increases, as regulated by 30 CFR 250.303(g).

The **Tables 4-49 and 4-50** compares the predicted contributions to onshore pollutant concentrations from activities associated with the OCS Program in the CPA and EPA to the maximum allowable increases over a baseline concentration established under the air quality regulations. While the tables show that the OCS Program by itself would result in concentration increases that are well within the maximum allowable limits, a direct comparison between the two sets of figures is not possible. This is because the actual maximum allowable increase depends on the net change in emissions from all other sources in the area, both offshore and onshore, since the date the baseline level was established. Sources that were already in place at the applicable baseline date are included in the establishment of the baseline and the corresponding concentration and do not count in the determination of the maximum allowable increment. The increment is an additional amount of deterioration of air quality allowed under the PSD program above the baseline concentration. The baseline concentration was required to be established pollutants. For the Breton Class I Area, this baseline concentration was not established; therefore, the actual cap on the allowable onshore concentration is not known. Because of the concern that some of the Class I area increments may be consumed, MMS has been working with FWS to initiate a study of the baseline for the Breton Wilderness Area. The MMS and FWS have been working towards this proposed Breton Air Quality Study for several years now. Recently, meetings have been held with representatives of USEPA's headquarters and regional offices, as well as representatives from the affected State air boards and from industry. The baseline dates have been established and 1988 and 1977 are the baseline inventory years for NO_x and SO_x, respectively. The intent of this study will be to establish a baseline inventory and then to select an appropriate model to use for modeling the baseline concentration, as well as the current concentration. These two modeled concentrations can then be compared to determine the amount of increment consumed.

The MMS has instituted a program in postlease operations to evaluate all activities within a 100-km radius of the Breton Wilderness Area that could result in potential SO_2 and NO_2 impacts to this Class I area. Mitigating measures, including low sulphur diesel fuels and stricter air emissions monitoring and reporting requirements, are required for sources that are located within 100 km of the Breton Class I Area and that exceed emission levels agreed upon by the administering agencies.

For CO, a comparison of emission rates to MMS exemption levels is used to assess impact. The formula to compute the emission rates in tons/yr for CO are $3{,}400 \bullet D^{2/3}$; D represents distance in statute miles from the shoreline to the source. This formula is applied to each facility. The CO exemption level is 7,072 tons/yr for a facility at the Federal/State boundary line, which is the nearest point to shore of any facility in Federal waters. Therefore, the 7,072 tons/yr figure is the most restrictive emissions threshold for any facility in the OCS. The average emission rate for a production platform is 8.1 tons/yr, but some vessels have a higher emission rate. Nonetheless, if the total CO emissions for the entire GOM (at the high end of the range) were taken and assigned to the current number of production platforms (1,820), this would still only result in an emissions rate of approximately 7.1 tons/yr. Not all platforms are located at the 3-mi line; therefore, most platforms have even larger exemption levels than the one used in this example.

Suspended particulate matter is important because of its potential in degrading the visibility in national wildlife refuges or recreational parks designated as PSD Class I areas. The impact depends on emission rates, particle size, and chemical composition. Particle size used in this analysis represents the equivalent diameter, which is the diameter of a sphere that would have the same settling velocity as the particle. Particle distribution in the atmosphere has been characterized as being largely trimodal (Godish, 1991) with two peaks located at diameters smaller than 2 m and a third peak with a diameter larger than 2 m. Particles with diameters of 2 m or larger settle very close to the source (residence time of approximately ½ day) (Lyons and Scott, 1990). For particles smaller than 2 m, which do not settle fast, wind transport determines their impacts. The PM_{10}'s are emitted at a substantially smaller rate than the two pollutants modeled with OCD; hence, impacts from PM_{10} would be expected to be even smaller because chemical decay was not employed in this dispersion modeling. A straight ratio can be employed to give an impact in the Class I area of 0.08 $\mu g/m^3$ for the annual average and 0.09 $\mu g/m^3$ for the 24-hr average. Therefore, suspended matter is estimated to have a minimal effect on the visibility of PSD Class I areas.

The amount of power generation that occurs during the period 2003-2042 is very difficult to predict because it depends on many nonquantifiable factors. Therefore, different sets of assumptions result in different estimates. The envelope of predictions shows that energy consumption should increase up to the year 2010; after this, predictions show more variation but generally indicate an increase of energy consumption. Because energy production is the largest single pollutant generator, one would suspect emissions would also increase (USDOE, 1990). However, advances in control technology and use of alternative energy sources can change the correlation between energy production and emissions. The available information (USDOE, 1990) indicates that SO_x emissions from energy generation decreased 16.4 percent between 1970 and 1987. Other pollutants that showed a decrease over the 1970-1987 period are particulate matter and NO_x. Although CO and VOC increased over the same period, the overall amount of emitted pollutants decreased.

Emissions of the criteria pollutants related to industrial activities decreased over the 1970-1987 period. The reduction in the total amount of pollutants was 51 percent (Godish, 1991). The projected increase in employment (**Chapter 3.3.5.5.**, Economic Factors) can be interpreted as an increase of industrial activities. However, if the decreasing trend of emissions holds during the next 40 years, it is reasonable to estimate that industrial emissions would not increase; at worst, they would remain at present levels.

Even though oil and gas production in State waters is known to be taking place, the States have not provided MMS with information regarding the actual number of production facilities in their jurisdiction. Without this information, MMS cannot estimate emissions from these facilities. Other mobile emission sources that are not included here are military vessels, commercial fishing, recreational fishing, commercial marine vessel, ocean-going barges, and LOOP. The MMS is currently in the process of gathering this information for assessing the impact on air quality.

Summary and Conclusion

The methodology used for this impact analysis is based on the OCD modeling. This analysis indicates that the emissions of pollutants into the atmosphere from the activities associated with the cumulative offshore scenario are not projected to have significant impacts on onshore or offshore air quality for a proposed lease sale.

Emissions of pollutants into the atmosphere from the activities associated with the cumulative offshore scenario are not projected to have significant impacts on onshore or offshore air quality because of the prevailing atmospheric conditions, emission heights, emission rates, and the distance of these emissions from the coastline and each other. It is assumed that new source performance standards and best available control technology would be used on all onshore facilities and that additional controls or offsets may be required in some areas to meet air quality standards imposed by existing regulations. Future development projects must determine the significance of impacts by analyzing modeling data and comparing the results to applicable PSD increments.

Onshore impacts on air quality from emissions from cumulative OCS activities are estimated to be within Class II PSD allowable increments. Potential cumulative impacts from a proposed action are well within the PSD Class I allowable increment. The incremental contribution of a proposed action (as analyzed in **Chapter 4.2.1.1.**) to the cumulative impacts is not significant or expected to alter onshore air quality classifications.

4.5.2. Impacts on Water Quality

Cumulative impacts to water quality would result from a proposed action, ongoing oil and gas activities in OCS and State waters, and all other sources that affect water quality, both natural and anthropogenic. Non-OCS sources include industrial, recreational, agricultural, and natural activities as well as oil and gas activities in state waters. An overview of the present status of water quality in the coastal and marine waters of the potentially impacted area is given in **Chapter 3.1.2.** The types of impacts and the impacts from a proposed action were discussed in **Chapters 4.1.1.4., 4.2.1.2., and 4.4.2.**

The OCS-related activities that can impact water quality include drilling wells, installation and removal of platforms, laying pipelines, service vessel operations, production operation discharges and supporting facility and infrastructure discharges. A proposed action is projected to result in the installation of two production structures. A total of 5-9 structures may be added from the EPA OCS Program between 2003 and 2042 and 2,360-3,134 from the CPA OCS Program. At the same time, structures are being removed. An estimated 10-12 structures would be removed in the EPA between 2003 and 2042 and 5,350-6,110 in the CPA. More than 80 percent of the removals would be in water depths less than 60 m (i.e., on the continental shelf). Presently, approximately 400 OCS structures exist east of the Mississippi River. Routine oil and gas activities potentially degrade water quality through the addition of hydrocarbons, trace metals, and suspended sediment. Accidental spills of chemicals used in OCS activities or oil would also temporarily degrade water quality.

4.5.2.1. Coastal Waters

The leading causes of coastal and estuarine impairment are nutrients, pathogens, and oil and grease. The three leading sources of the impairment are urban runoff, agricultural sources and municipal sources (USEPA, 1999). Petroleum is ranked as the sixth leading source of coastal and estuarine water quality impairment.

In addition to the leading causes of impairment, oil and gas extraction support activities would contribute to the cumulative quality of coastal waters. Activities, which support oil and gas exploration, release hydrocarbons and trace metals to the water. These activities include bilge water from service vessels and point- and nonpoint-source discharges from supporting facilities and infrastructure. A proposed action is expected to result in 8,000-9,000 vessel trips over its lifetime. About 200-225 trips are projected annually. About 21,000-42,000 vessel trips are projected as a result of the EPA OCS Program and 10,664,000-10,996,000 as a result of the CPA OCS Program. Discharges from service vessels are regulated by USCG to minimize cumulative impacts. The USEPA regulates support facility discharges, including waste water and storm water discharge. Only nonpoint-source discharges are not regulated and data do not exist to evaluate the magnitude of this impact. The contribution is likely to be small in comparison to nonpoint-source discharges from the broad categories of urban and agricultural runoff which contribute to 50-60 percent of estuarine impairment (USEPA, 1999). If the EPA regulations which control service vessel and support facility discharges are followed, it is not expected that additional oil and gas activities would adversely impact the overall water quality of the region.

Dredging and channel erosion can add to the suspended load of local waterways. Support vessels and other activities such as commercial fishing and shipping use the waterways. Accurate information concerning the relative contribution of OCS activities to this source is not available. .

Accidental releases of chemicals or oil would degrade water quality during and after a spill and until a spill is either cleaned up or dispersed by natural processes. **Table 4-15** summarizes the projected oil spills from OCS and non-OCS activities according to number and assumed size. OCS sources contribute 11 percent of the total yearly volume of oil spilled to coastal waters for spills ≥1,000 bbl and 5 percent of the total yearly volume of oil spilled from spills <1,000 bbl. The effect on coastal water quality from spills estimated to occur from a proposed action are expected to be minimal relative to the cumulative effects from hydrocarbon inputs from other sources such as urban runoff, agriculture and municipal sources, and other releases as discussed in the National Research Council's report *Oil in the Sea* (NRC, 1985). The cumulative impacts to coastal water quality would not be changed over the long term as a result of a proposed action.

Summary and Conclusion

Water quality in coastal waters would be impacted by supply vessel discharges and usage, infrastructure discharges and nonpoint-source runoff. The impacts to coastal water quality from a proposed action are not expected to significantly add to the degradation of coastal waters as long as all regulations are followed.

4.5.2.2. Marine Waters

Water quality in marine waters would be impacted by the discharges from drilling and production activities. Sources not related to oil and gas activities that can impact marine water quality include bilge water discharges from large ships and tankers, natural seepage of oil and trace metals, and pollutants from coastal waters that are transported away from shore. These include runoff, river input, sewerage discharges, and industrial discharges; and natural seepage of oil and trace metals.

Drilling activities add drilling mud and cuttings to the environment. From the MMS database, an average of 1,186 wells per year was spudded from 1996 to 2000; this rate is expected to decrease. A projected 30-40 wells would be drilled in support of a proposed action. The OCS Program is projected to result in the drilling of 131-456 exploratory and development wells in the EPA and 19,661-23,636 in the CPA between 2003 and 2042. The impacts from drilling were discussed in **Chapter 4.2.1.2.2.**, Marine Waters. Studies thus far indicate that as long as discharge regulations are followed, impacts to the marine environment from drilling activities are not significant. The NRC report (1985) on oil in the sea determined that other inputs of oil are much greater than the input of oil from oil and gas activities. Using an estimate of 532 Mbbl/yr of water produced on the OCS and an average of 29 mg/l of hydrocarbons in the water, roughly 0.002 million metric tons of oil and grease are added per year to the OCS from produced water. This amount of oil is very small relative to the estimated 0.097 Mta from natural seeps and other sources (**Chapter 3.1.2.2.**, Marine Waters). Support vessels also add hydrocarbon contamination by discharge of bilge water; however, the discharged bilge water should meet USCG regulations, thus minimizing impacts.

Limited information is available on the levels of trace metals in GOM marine waters and sediments and the relative sources. The USEPA (1993a and b) conducted detailed analyses of trace metal concentrations in exploration and production discharges and used the data to establish criteria for the discharge of drilling wastes. Impacts from trace metal concentrations in exploration and production discharges are not expected to be significant.

The source of mercury that accumulates in fish tissue is a current concern. As discussed previously, barite, which contains trace levels of mercury, is an essential component of drilling mud. USEPA regulations require barite to contain no more than 1 ppm of mercury. Actual mercury concentrations in barite are about 0.1 ppm (SAIC, 1991). The typical well in the EPA would generate about 230-270 bbl of WBF waste during the drilling interval prior to the changeover to SBF (**Tables 4-8(a) and (b)**). A proposed action would release less than 0.05 kg of mercury from barite to the environment. If the discharge of cuttings with a limited amount of adhered SBF is permitted by USEPA Region 4 in the future, some additional mercury in barite would be discharged with the adhered SBF.

It is generally accepted that the widespread mercury problem is caused by atmospheric pollution. Both long-distance transport through the air and localized deposition around emissions sources can be important. Major sources to the atmosphere are metals mining and smelting; coal-fired utilities and industry; and the mining, use and disposal of mercury itself (Atkeson, 1999). Mercury deposition is monitored at sites throughout the country. At the Chassahowitzka National Wildlife Refuge on the GOM in Citrus County, Florida, 13-15 $\mu g/m^2$ of mercury were deposited annually from 1998 to 2000 (NADP, 2002). If mercury were to be deposited over the area of a proposed action (5,970 km^2) at this same rate, 78-90 kg mercury would be deposited each year. This number may be an overestimate since the NWR is closer to the abundant onshore atmospheric sources relative to the offshore sources.

Riverine inputs of mercury are another important source of mercury. Neff (2002) estimated that air deposition and riverine inputs contribute 102,000 lb per year of mercury to the GOM, while oil and gas operations contribute about 346 lb per year (0.3%). However, the EPA OCS waters may be less impacted than coastal and estuarine waters because of the distance from the freshwater and sediment influx, particularly the Mississippi River.

Accidental spills of chemicals and oil are expected to impact water quality on a temporary basis and only close to the spill. **Table 4-14** indicates that spills from OCS operations contribute 10 percent of the oil that results from spills in the GOM. The OCS spills contribute 0.001 million metric tons while non-OCS spills contribute 0.01 Mta. Spill response efforts, as well as winds, waves, and currents should rapidly disperse any spill and reduce impacts.

Summary and Conclusion

Cumulative impacts on the water quality of the marine environment result from the addition of discharges from exploratory and production activities to a relatively pristine environment. As long as discharge criteria and standards are met, impacts to the marine environment are not expected to be significant.

4.5.3. Impacts on Sensitive Coastal Environments

4.5.3.1. Coastal Barrier Beaches and Associated Dunes

This cumulative analysis considers the effects of impact-producing factors related to a proposed action, prior and future OCS lease sales in the GOM, State oil and gas activities, other governmental and private projects and activities, and pertinent natural processes that may affect barrier beaches and dunes. Specific impact-producing factors considered in this cumulative analysis include erosion and reduced sedimentation, beach protection and stabilization projects, oil spills, oil-spill response and cleanup activities, pipeline landfalls, navigation channels, and recreational activities.

Natural Land Building and Movement

Erosion of barrier islands in coastal Louisiana and easternmost Texas is related to the stages of construction and destruction of the Mississippi River Delta. The Mississippi River is the most influential direct and indirect source of sand-sized and other sediments to coastal landforms in Louisiana. The location of the river determines which areas of the deltaic plain accrete and erode. Typically, rivers and their tributaries build land where they flood the delta and discharge to the GOM. Land erodes and subsides where sediments are no longer received from the river or other sources

Since the lower Mississippi River was completely leveed and channeled by the early 1930’s, the vast majority of land-building sediments were channeled to the end of the Bird Foot Delta (coastal Subarea LA-3), from where they were largely distributed to deepwater areas of the continental slope. Levees and channelization ended the once-significant land building in Louisiana and set circumstances toward deltaic degradation and subsidence, as if the river had abandoned this area of the coast.

Within a decade after the Civil War, the State of Louisiana connected the Mississippi, Red, and Atchafalaya Rivers for navigational purposes, which began the diversion of the more sediment-laden waters of the Mississippi River to the Atchafalaya River. By 1932, the Federal Government diverted the Red River and increased Mississippi River flow to the Atchafalaya River for flood control. By 1962, the Federal Government constructed the Old River Control Structure, which diverts approximately 30 percent of the Mississippi River flow to the Atchafalaya River. This diversion also led to the development of a new deltaic lobe in the Atchafalaya Bay (coastal Subarea LA-2).

Since the 1950’s, the suspended sediment load of the Mississippi River has decreased more than 50 percent, largely as a result of dam and reservoir construction (Turner and Cahoon, 1988) and soil conservation measures within the drainage basin. Sediment loads in the Atchafalaya River also decreased as a result.

Reduced sediment supply to the Louisiana coast has contributed to erosional forces becoming dominant. Erosional reworking of deltaic sediments winnows away the lighter sediments and retains the heavier, sand-sized materials that build barrier beaches. Unfortunately, very little of these coarser materials are present in the deltaic deposits of these regions. Consequently, these beaches are rapidly retreating landward and will continue to do so into the foreseeable future. Generally under these circumstances, installation of facilities on these beaches or dunes or removal of large volumes of sand from this littoral system can cause strong, adverse impacts. One of the least stable beach and dune systems is at Fourchon in Lafourche Parish, where tank farms and other businesses have been forced to move inland, away from the rapidly eroding beach.

The beaches and dunes of the Chandeleur Islands to the east of the Mississippi River Delta are not dependent on a fluvial source of sand. These islands are nourished by the sandy barrier platforms beneath them (Otvos, 1980). Reduced discharges of fluvial sediment into the coastal zone will not affect these barriers. Still, their sand supplies are limited and they have not recovered rapidly after hurricanes of the last decade.

The barrier landforms in the States of Mississippi, Alabama, and Florida are not directly dependent on a fluvial (river) source of sand. Rather, these islands appear to be nourished by the sandy barrier platforms beneath them (Otvos, 1980). These landforms include the Dog Keys of Mississippi Sound; Santa Rosa Island, Florida; and the mainland beaches between the mouth of Mobile Bay, Alabama, and Cape San Blas, Florida. Typically, the sand drift moves these islands and mainland barrier features westward. Hence, the eastern ends of the islands are generally eroding, while their westward ends are building. The exceptions to this are Grand Isle and Eastern Chenier Caminada in Louisiana and the coastal area from Mexico Beach to Cape San Blas, Florida, which are moving eastward.

Average erosion rate over the entire Texas coast has been 2.1 m/yr. During this century, the annual rate of coastal landloss in Texas has increased from 13 ha at the turn of the century to nearly 65 ha in 1980 (Morton, 1982). These trends are caused by (1) a natural decrease in sediment supply as a result of climatic changes over the past few thousand years (Morton, 1982), (2) dam construction upstream on coastal rivers that have trapped sand-sized sediments, and (3) seawall construction along eroding stretches of islands that has reduced the amount of sediment introduced into the littoral system by shore erosion. The Texas Chenier Plain receives reworked sediments discharged by the Mississippi River, which have decreased by more than 50 percent since the 1950's. Reductions in sediment supply along the Texas coast will continue to have a significant adverse impact on barrier landforms there.

Subsidence, erosion, and dredging of inland coastal areas and the concurrent expansion of tidal influences, particularly as seen in Louisiana, continually increases tidal prisms around the Gulf. These changes will cause many new natural, tidal channels to be opened, deepened, and widened not only to the GOM but also between inland waterbodies to accommodate the increasing volumes of water that are moved by tides and storms. These changes will cause adverse impacts to barrier beaches and dunes that will be incremental in nature.

Storms and Beach Stabilization Efforts

Efforts to stabilize the GOM shoreline have adversely impacted barrier landscapes in various areas along the Gulf Coast. Large numbers and varieties of stabilization techniques, such as groins, jetties, and seawalls, as well as artificially maintained channels and jetties, installed to stabilize navigation channels have been applied along the Gulf Coast. Undoubtedly, efforts to stabilize the beach with seawalls, groins, and jetties in Texas and Louisiana have contributed to coastal erosion by depriving downdrift beaches of sediments, which accelerates erosion there (Morton, 1982), and by increasing or redirecting the erosional energy of waves. Over the last 20 years, dune and beach stabilization have been better accomplished by using more natural applications such as sand dunes, beach nourishment, and vegetative plantings.

A variety of beach and barrier island restorative measures have been brought about as the population has become more aware of barrier island and beach problems. During the mid-1980's, the COE contracted with the State of Louisiana and the Jefferson Parish governments to replenish beach sand on Grand Isle, Louisiana. During the 1990's, the State of Louisiana and Federal Government joined in a partnership through the Coastal Wetlands Protection, Planning and Restoration Act (CWPPRA) to address and, where possible, correct the deterioration of wetlands and barrier islands along Louisiana's Gulf Coast and elsewhere.

In addition to Louisiana, the States of Alabama and Florida (in association with MMS) have pursued the use of sands dredged from Federal waters to restore and nourish barrier beaches and islands. The costs, though, seem to be prohibitive.

Large numbers and varieties of stabilization techniques and structures have been applied along the Louisiana, Alabama, and Florida barrier coasts to abate erosion. Generally, efforts to stabilize barrier shorelines using hard, engineered structures have trapped sediment on the updrift sides of the structures. On their downdrift sides, the structures have usually adversely impacted barrier landscapes by accelerating erosion. Since 1980, dune and beach stabilization have been better accomplished by using more natural applications such as sand dunes, beach nourishment, vegetative plantings, and avoidance.

Neither the proposed action nor other known OCS-related development would increase destabilization of coastal dune or barrier beaches. No coastal roads would be built, no barrier beaches would be dredged for landfalls, no beach construction would be needed, no new navigation canals would be dredged, and the likelihood of OCS-related oil spills coming ashore is very low.

Hurricanes will continue to place significant erosional pressures on beaches and dunes that generate quick and tumultuous impacts. Storms that are generated by cold fronts also generate similar, less-intense erosional pressures repeatedly over the fall, winter, and spring. Local governments of Santa Rosa Island and the Destin area in Florida, in association with the COE, built dunes to protect developed regions of those areas and to reinitiate natural dune development where dunes were severely damaged by Hurricane Opal in 1995 (*Pensacola News Journal*, 1998a).

Land Development

Most barrier beaches in Louisiana and Mississippi are relatively inaccessible for recreational use because they are located at a substantial distance offshore or are in coastal areas with limited road access.

Several highways were built into the barrier-dune fields in Alabama and Florida, and were constructed somewhat parallel to the beach, through the dune fields, or immediately behind them over associated coastal flats (USDOI, FWS, 1982a and b). These highways include

- Mobile County Road 2, constructed into the dune field of the western spit of Dauphin Island, Alabama;
- Alabama Highway 180, constructed through the dune system for the length of Morgan Peninsula, Alabama;
- Alabama Highway 182, constructed through the dune field eastward from Pine Beach on the Gulf beach of Morgan Peninsula, through Gulf Shores, Alabama, to Perdido Key, and into Florida;
- Florida Highway 292 beginning at Alabama Highway 182 and continuing eastward through the dunes to Gulf Beach where it turns inland to Pensacola, Florida;
- Florida Highway 399, constructed from Fort Pickens, Florida, eastward to Navarre Beach, Florida, about half the length of Santa Rosa Island;
- Highway 30/Federal Highway 98, constructed in and out of barrier-dune fields from Fort Walton Beach, Florida, eastward to about Marimar Beach, Florida;
- Federal Highway 98A, known as the Miracle Strip or Panama City Beach, constructed through the dune system just east of that city;
- Florida Highway 30E, constructed through the dune systems of St. Joseph Peninsula;
- Florida Highway 30B, constructed through the dune systems of Indian Peninsula; and
- Florida Highway 300, constructed through the dunes of St. George Island.

Over the years, areas along these roads have been popular for recreation. Properties along these roads have become extensively developed. As the land was subdivided into smaller parcels, many secondary roads and tracks were constructed into the dunes for access and further development. Vehicle and pedestrian traffic on sand dunes stresses and reduces the density of vegetation that binds the sediment and stabilizes the dune. Unstable dunes are more easily eroded by wind and wave forces.

Development of Navarre Beach in Florida (Florida Highway 399) and Perdido Key off Alabama and Florida (Alabama Highway 182 and Florida Highway 292) appears to be following that dune-destructive trend. Development causes damage due to the clearing and leveling of land for buildings and parking lot and subsequent trampling by recreational users.

Many communities along these roads have come to realize that barrier beaches and dune systems are important to their economies, safety, and regional aesthetics. The community of Navarre Beach, Florida on Santa Rosa Island formulated its Master Development Plan, which calls for recreational, residential, commercial, public, and resort developments on the sound and GOM sides of Florida Highway 399 (*Pensacola News Journal*, 1998b-d). Several high-rise condominiums are being constructed or have been approved for construction in Navarre Beach.

The *Pensacola News Journal* (1998e) reported a contract for the sale of an 8-acre tract of land on Perdido Key Drive in Alabama to a developer who had declared the intention to build condominiums. Apparently, the local government and the State of Alabama have agreed to limit the number of residential units to 7,300 and hotel rooms to 1,000. At that time, the agreement instituted a 260 percent and a 1,000-2,000 percent increase in the number of residential units and hotel rooms on that island, respectively.

Population increases along the barrier coasts will inevitably and cumulatively increase adverse impacts on the barrier dunes in areas where road access is made available. Florida and Alabama have taken measures to reduce these impacts. Picking sea oats and other dune vegetation is illegal. Vehicular traffic is restricted. Where foot traffic across the dunes is popular, boardwalks may be required. Developments in the dune fields are required to mitigate many of their adverse impacts. There is no incremental contribution of a proposed action to impacts on barrier dunes or beaches through coastal road access and use.

Oil Spills

Sources and probabilities of oil entering waters of the GOM and surrounding coastal regions are discussed in **Chapter 4.3.1.2.**, Risk Charaterization for Proposed Action Spills. Inland spills that do not occur in the vicinities of barrier tidal passes are more likely to contact the landward rather than the ocean side of a barrier island. Hence, no inland spills are expected to significantly contact barrier beaches (**Chapter 4.4.3.1.**).

Most spills occurring in offshore coastal waters are assumed to proportionally weather and dissipate similar to the weathering. Dispersants are not expected to be used in coastal waters. Unfavorable winds and currents would further diminish the volume of oil that might contact a beach. A persistent, northwesterly wind might preclude contact. Slicks that contact land are assumed to affect barrier beaches (**Chapter 4.4.3.1.**). **Chapters 3.2.1.1., 4.2.1.3.1., and 4.4.3.1.** discuss the probability that tide levels could reach or exceed the elevations of sand dune vegetation on barrier beaches ranges by 0-16 percent, depending on the particular coastal setting and the elevation of the vegetation. The strong winds that would be needed to produce unusually high tide levels would also disperse the slick over a larger area than is being considered in the current analysis. The probabilities of spill occurrence and contact to barrier beaches and sand-dune vegetation are considered very low. Hence, contact of sand-dune vegetation by spilled oil is not expected to occur. Furthermore, the Mississippi River discharge would help break up a slick that might otherwise contact Plaquemines Parish, the most likely area of contact. The spreading would reduce the oil concentrations contacting the beach and vegetation, greatly reducing impacts on vegetation.

The barrier beaches of Deltaic Louisiana have the greatest rates of erosion and landward retreat of any known in the western hemisphere, as well as among the greatest rates on earth. Long-term impacts of contact to beaches from spills could occur if significant volumes of sand were removed during cleanup operations. Removing sand from the coastal littoral environment, particularly in the sand-starved transgressive setting of coastal Louisiana, could result in accelerated coastal erosion. Spill cleanup is difficult in the inaccessible setting of coastal Louisiana. This analysis assumes that Louisiana would require the responsible party to clean the beach without removing significant volumes of sand or to replace removed sands. Hence, cleanup operations are not expected to cause permanent effects on barrier beach stability. Within a few months, adjustments in beach configuration may result from the disturbance and movement of sand during cleanup.

The results of an investigation on the effects of the disposal of oiled sand on dune vegetation in Texas showed no deleterious impacts on existing vegetation or colonization of the sand by new vegetation (Webb, 1988). Hence, projected oil contacts to small areas of lower elevation sand dunes are not expected to result in destabilization of the sand dune area or the barrier landform.

Some oil would penetrate to depths beneath the reach of the cleanup methods. The remaining oil would persist in beach sands, periodically being released when storms and high tides resuspend or flush through beach sediments. During hot, sunny days, tarballs buried near the surface of the beach sand may liquefy and cause a seep to the sand surface.

Pipelines

Many of the existing OCS-related and other pipeline landfalls have occurred on barrier landforms (**Table 4-7** and **Chapter 3.3.5.9.2.**, Pipeline Infrastructure for Transporting State-Produced Oil and Gas). Construction of 23-38 new pipeline landfalls is expected as a result of the OCS Program (**Chapter 4.1.2.1.7.**, Coastal Pipelines). An MMS study, as well as other studies (Wicker et al., 1989; LeBlanc, 1985; Mendelssohn and Hester, 1988), have investigated the geological, hydrological, and botanical impacts of pipeline construction on and under barrier landforms in the GOM. In general, the impacts of existing pipeline landfalls since 1975 were minor to nonexistent with current installation methods. In most cases, no evidence of accelerated erosion was noted in the vicinity of the canal crossings if no shore protection for the pipeline was installed on the beach and if no remnant of a canal remained landward of the beach. Wicker et al. (1989) warn that the potential for future breaching of the shoreline remains at the sites of flotation canal crossings where island width is small or diminishing because of erosion or the sediments beneath the sand-shell beach plugs are unconsolidated and susceptible to erosion.

Numerous pipelines have been installed on the bay side of barrier islands and parallel to the barrier beach. With overwash and shoreline retreat, many of these pipeline canals serve as sediment sinks, resulting in the narrowing and lowering of barrier islands and their dunes and beaches. Such islands and beaches were rendered more susceptible to breaching and overwash. This type of pipeline placement was quite common in Louisiana, but it has been discontinued.

An area of special concern along the south Texas coast is the Padre Island National Seashore, which is in coastal Subarea TX-1. At present, one OCS pipeline, which carries some condensate, crosses the northern end of Padre Island. For 2003-2042, 0-2 new pipeline landfalls are projected for coastal Subarea TX-1. Corpus Christi, north of Padre Island, is one of the possible shuttle tanker ports.

The contribution of the OCS Program to vessel traffic in navigation channels is described in **Chapters 3.3.5.8.2. and 4.1.2.1.8.** A portion of the impacts attributable to maintenance dredging and wake erosion of those channels would be in support of the OCS Program. Mitigative measures are assumed to occur, where practicable, in accordance with Executive Order 11990 (May 24, 1977). During the 40-year analysis period, beneficial use of dredged material may increase, thereby reducing the continuing impacts of navigation channels and jetties.

Navigation Channels

No new navigation channels between the GOM and inland regions are projected for installation. The basis of this assumption is the large number of existing navigation channels that can accommodate additional navigation needs. Some new inland navigation channels would be dredged to accommodate the inland oil and gas industry, developers, and transportation interests. Some channels may be deepened or widened to accommodate projected increases in deeper-draft petroleum production and larger cargo vessels that are not related to OCS petroleum production.

Most barrier beaches in the Louisiana are relatively inaccessible for recreational use because they are either located a substantial distance offshore (Mississippi) or in coastal areas with limited road access (Louisiana). Few beaches in these two States have been, or are likely to be, substantially altered to accommodate recreational or industrial construction projects in the near future.

Most barrier beaches in Texas, Alabama, and Florida are accessible to people for recreational use because of road access; their use is encouraged. Recreational vehicles and even hikers have been problems where road access is available and where the beach is wide enough to support vehicle use, as in Texas, Alabama, Florida, and a few places in Louisiana. Areas without road access will have very limited impacts by recreational vehicles.

Summary and Conclusion

River channelization, sediment deprivation and rapid submergence have resulted in severe, rapid erosion of most of the barrier and shoreline landforms along the Louisiana coast. The barrier system of coastal Mississippi and Alabama is well supported on a coastal barrier platform of sand. The Texas coast has experienced landloss because of a decrease in the volume of sediment delivered to the coast because of dams on coastal rivers, a natural decrease in sediment supply as a result of climatic changes during the past several thousand years, and subsidence along the coast.

Beach stabilization projects are considered by coastal geomorphologists and engineers to accelerate coastal erosion. Beneficial use of maintenance dredged materials could be required to mitigate some of these impacts.

No construction of new navigation channels through barrier beaches and related dunes are projected to support either OCS or non-OCS activities in the EPA. Some existing channels may be deepened or widened to accommodate deeper draft vessels or greater traffic volumes that would support a variety of activities. Most OCS-related trips in the navigational cumulative-activity area would use the channels that serve Port Fourchon and Venice, Louisiana; and Mobile, Alabama. With continued oil and gas development in Federal waters off Texas, Louisiana, Mississippi, Alabama, and potentially the Florida Panhandle, OCS use of coastal channels in those States may increase. Most of these channels have jettied entrances to reduce channel shoaling. Typically, the channels and their related jetties serve as sediment sinks that cause some accelerated erosion down drift of these structures.

The impacts of oil spills from both OCS and non-OCS sources to the sand-starved Louisiana coast should not result in long-term alteration of landform if the beaches are cleaned using techniques that do not significantly remove sand from the beach or dunes. The cleanup impacts of these spills could result in short-term (up to 2 years) adjustment in beach profiles and configurations as a result of sand removal and disturbance during cleanup operations. Some contact to lower areas of sand dunes is expected. These contacts would not result in significant destabilization of the dunes.

Under the cumulative scenario, new OCS-related pipelines are projected. These pipelines are expected to be installed using modern techniques such as trenchless or horizontal drilling, which allows little to no impacts to the barrier islands and beaches. Existing pipelines, in particular those that are parallel and landward of beaches, that had been placed on barrier islands using older techniques that left canals or shore protection structures exposed, have caused and will continue to cause barrier beaches to narrow and breach.

Recreational use of many barrier beaches in the western and eastern GOM is intense because of their accessibility by road. Major dune-impacting developments in Florida and Alabama are roads and canals constructed into and behind barrier-dune fields. These roads encourage residential and commercial developments and a variety of recreational activities that have adversely impacted sand dunes and beaches. Florida and Alabama have taken measures to reduce impacts to barrier dunes. The barrier systems of Louisiana and Mississippi are not generally accessible, except by boat. Federal, State, and local governments have made efforts over the last 10 years to slow the landward retreat of Louisiana's GOM shorelines.

In conclusion, coastal barrier beaches have experienced severe adverse cumulative impacts from natural processes and human activities. Natural processes are generally considered the major contributor to these impacts. Human activities cause both severe local impacts as well as the acceleration of natural processes that deteriorate coastal barriers. Human activities that have caused the greatest adverse impacts are pipeline canals, channel stabilization, and beach stabilization structures. Deterioration of GOM barrier beaches is expected to continue in the future. Federal, Louisiana, and parish governments have made efforts over the last 10 years to slow the landward retreat of Louisiana's GOM shorelines. The incremental contribution of a proposed action compared to cumulative impacts on coastal barrier beaches and dunes impacts is expected to be very small.

4.5.3.2. Wetlands

This cumulative analysis considers the effects of impact-producing factors related to a proposed action, prior and future OCS sales, State oil and gas activities, other governmental and private activities, and pertinent natural processes and events that may occur and adversely affect wetlands during the analysis period. The effects of pipelines, canal dredging, navigation activities, and oil spills on wetlands are described in **Chapters 4.2.1.3.2. and 4.4.3.2.** Other impact-producing factors and information relevant to the cumulative analysis are discussed below.

Many of man's activities have resulted in landloss either directly or indirectly by accelerating natural processes. Until the Mississippi River was channelized and leveed during the early 1900's, floodwaters layered sediment over the active deltaic plain, countering ongoing submergence and building new land. Areas that did not receive sediment-laden floodwaters lost elevation. Human intervention (channelization and leveeing), though, has interrupted the process of renewal. In addition, the Mississippi River's suspended sediment load has decreased more than 50 percent since the 1950's, largely as a result of dam and reservoir construction (Turner and Cahoon, 1988) and soil conservation practices in the drainage basin. Also, construction of the GIWW and other channelization projects associated with its development has severely altered natural drainage patterns along many areas of the Texas coast.

The hydrology of a wetland is probably the single most important factor for the maintenance of the structure and function of a particular wetland (Mitsch and Gosselink, 1995). Hydrologic conditions influence abiotic conditions such as nutrient availability, soil redox conditions, and salinity. Saltwater intrusion, as a result of river channelization and canal dredging, is a major cause of coastal habitat deterioration (including seagrass communities) (Tiner, 1984; National Wetlands Inventory Group, 1985; Cox et al., 1997). Productivity and species diversity associated with wetlands and submerged vegetated habitat in coastal marshes of Louisiana and Texas is greatly reduced by saltwater intrusion (Stutzenbaker and Weller, 1989; Cox et al., 1997). These types of changes in hydrology typically have significant long-term impacts on the wetland system, potentially leading to wetland loss (Johnston and Cahoon, in preparation). A number of studies have demonstrated that pipeline canals, including channel theft (freshwater drainage followed by saltwater intrusion), change hydrology (Craig et al., 1980; Sikora and Wang 1993; Turner and Rao 1990; Wang 1987; Cox et al., 1997).

Wetland loss rates in coastal Louisiana are well documented to be as high as 10,878 ha/yr (42 mi^2/yr) during the late 1960's. One analysis method shows that the landloss rate in coastal Louisiana from 1972 to 1990 slowed to an estimated 6,475 ha/yr (25 mi^2/yr) (Louisiana Coastal Wetlands Conservation and Restoration Task Force, 1993). A second methodology showed a wetland loss rate of 9,072 ha/yr (35 mi^2/yr) in the coastal zone of Louisiana during the period of 1978-1990 (USDOI, GS, 1998).

Development of wetlands for agricultural, residential, and commercial uses affects coastal wetlands. During 1952-1974, an estimated 1,233 ha (5 mi^2) of wetlands were converted to urban use in the Chenier Plain area of southwestern Louisiana (Gosselink et al., 1979). During 1956-1978, an estimated 21,642 ha (84 mi^2) of urban or industrial development occurred in the Mississippi deltaic plain region of southern Louisiana (Bahr and Wascom, 1984). Submergence rates in coastal Louisiana have ranged from 0.48 to 1.3 cm per year (Baumann, 1980; Ramsey et al., 1991). This submergence is primarily due to subsidence and the elimination of river flooding (due to channelization and leveeing). Flooding deposited sediment over the delta plains, which either slowed subsidence, maintained land elevations, or built higher land elevations, depending upon the distances from the river and the regularity of flooding for each region of interest. A secondary cause of land submergence is sea-level rise.

Chapter 4.3.1.2.1., Frequency, Magnitude, and Source of Spilled Oil from a Proposed Action, provides projections of oil spills as a result of a proposed action. Their projected effects on wetlands are described in **Chapter 4.4.3.2.** This cumulative analysis considers petroleum and products spills from all sources, inclusive of the OCS Program, imports, and State production.

Flood tides may bring some oil through tidal inlets into areas landward of barrier beaches. The turbulence of tidal water passing through most tidal passes would break up the slick, thereby accelerating dispersion and weathering. For the majority of these situations, light oiling of vegetated wetlands may occur, contributing less than 0.1 m^2 on wetland surfaces. Any adverse impacts that may occur to wetland plants are expected to be very short lived, probably less than one year.

Coastal OCS spills could occur as a result of pipeline accidents and barge or shuttle tanker accidents during transit or offloading. The frequency, size, and distribution of OCS coastal spills are provided in **Chapter 4.3.1.2.1.** Impacts of OCS coastal spills are discussed in **Chapter 4.4.3.2.** Non-OCS spills can occur in coastal regions as a result of import tankers, coastal oil production activities, and petroleum product transfer accidents (**Chapter 4.3.1.1.2.4.**).

Under this scenario, spills that occur in or near Chandeleur or Mississippi Sounds could potentially impact wetland habitat in or near the Gulf Islands National Seashore and the Breton National Wildlife Refuge and Wilderness Area. Because of their natural history, these areas are considered areas of special importance, and they support endangered and threatened species. Although the wetland acreage on these islands is small, the wetlands make up an important element in the habitat of the islands. In addition, the inlets that connect Mississippi Sound with the marsh-fringed estuaries and lagoons within the islands are narrow; therefore, a small percentage of the oil that contacts the Sound side of the islands would be carried by the tides into interior lagoons.

Projected new onshore facilities are described in **Chapter 4.1.2.1.**, Coastal Infrastructure, and **Table 4-7**. Federal and State permitting programs discourage facility placement in wetlands as much as is feasible; however, if the placement of a facility in a wetland is unavoidable, then adequate mitigation of all unavoidable impacts is required. Therefore, no significant impacts to wetlands are expected from construction of new facilities.

In order to understand and report the impact of OCS pipelines and navigational canal systems, their locations, routes, and impacts must first be identified and measured. Through a coordinated effort between the State of Louisiana and MMS, GOM pipeline networks have been documented into a GIS database and utilized to create a Statewide Louisiana pipeline GIS database. In addition, the USGS-BRD and MMS are currently investigating OCS-related pipeline and canal lengths found onshore in distinct habitat types in Texas, Louisiana, Mississippi, and Alabama. The MMS/USGS pipeline study will develop models that will aid in quantifying habitat loss associated with OCS activities. Preliminary results of this study have provided information for improving the effectiveness of workable mitigation techniques as well as identifying new mitigation techniques that are currently being used in areas where existing techniques have not been adequate or successful. Furthermore, this information is valuable in determining predictable widening and filling rates of OCS-related canals and for estimating how long typical canal mitigation structures effectively reduce adverse impacts.

Pipeline construction projects can affect wetlands in a number of ways. Pipeline installation methods and impacts are described in **Chapters 4.1.1.8.1. and 4.1.2.1.7.**, while the State oil and gas industry is generally described in **Chapter 4.1.3.1.** Two-thirds of OCS pipelines entering State waters tie into existing pipeline systems and do not result in new landfalls. Of the 70-120 new OCS pipelines projected to enter State waters, only 23-38 would result in new landfalls. Landfalls are expected to initially impact an immeasurable area of wetland habitat. After backfilling, productivity of the impacted acreage would be repressed for up to 6 years, converting some wetland habitat to open water. Pipeline maintenance activities that disturb wetlands are very infrequent and are considered insignificant.

Secondary impacts of pipeline canals are considered more damaging to coastal wetlands and associated habitats than primary construction impacts (Tabberer et al., 1985). Such impacts include expansion of tidal influence, saltwater intrusion, hydrodynamic alterations, erosion, sediment transport, and habitat conversion (Gosselink, 1984; Cox et al., 1997). **Chapter 4.2.1.3.2.** describes secondary wetland loss due to OCS-related pipeline and navigation canal widening. During reviews of pipeline projects for Federal and State permits, agencies consistently comment with concern upon the extent of secondary impacts. As a result, structures engineered to mitigate secondary adverse impacts are included as permit requirements for canal and pipeline construction through wetlands. The number of these mitigative structures throughout the GOM coastal areas is unknown. Maintenance of mitigation structures on pipeline canals is only required for 5 years (a rarely enforced stipulation). Where mitigative structures are not regularly maintained, secondary impacts may hasten habitat loss to eventually equal or surpass the impacts that would have occurred had the structure not been installed. The nonmaintenance of mitigative structures can lead to their deterioration and eventual failure, allowing indirect and, at times, adverse impacts on wetlands to proceed. These adverse impacts include saltwater intrusion, reduction of freshwater inflow, sediment erosion and export, expansion of tidal influence, and habitat conversion. Although the extent of impacts caused by failure to maintain mitigation structures is unknown, such impacts are believed to be significant (Gosselink, 1984; Tabberer et al., 1985; Turner and Cahoon, 1988).

Most canals dredged in coastal Louisiana and Texas have occurred as a result of onshore oil and gas activities. Drilling and production activity at most coastal well sites in Louisiana and Texas require rig access canals. Access canals and pipelines to service onshore development are pervasive throughout the coastal area in Louisiana; 15,285 km of pipeline canals have been installed to carry onshore production (USDOI, GS, 1984). Typical dimensions of an access canal, as indicated on permits during 1988, were 366-m long by 20-m wide with a 0.5-ha drill slip at the end.

In 1988, the COE received applications for the installation of 123 km of pipelines and for the dredging of more than 11 km of new oil-well access canals through wetland areas. This survey took place during a period (1984 through 1990) of suppressed oil and gas activities. Assuming that this level of activity persists for the analysis period, the direct impacts from the COE-permitted dredging are hard to measure but may lead to the conversion of wetland habitat to open water. Additionally, more wetland habitat would be buried by spoil banks along the channel margins, converting some wetlands acreage to bottom land or shrub-scrub habitat.

As discussed in **Chapter 4.1.1.8.2.**, Service Vessels, the magnitude of future OCS activities is being directed towards deeper water, which would require larger service vessels for efficient operations. Ports housing OCS-related service bases that can accommodate deeper-water vessels are described in **Chapter 4.1.2.1.1.** Empire and Cameron, Louisiana, are considered marginally useable for OCS-related, shallow-water traffic.

Ports containing service bases with access channels less than 4.5 m (15 ft) deep may decide to deepen their channels to capture portions of OCS activities projected for deep water. Typically, channels greater than 6-7 m deep would not be needed to accommodate the deepwater needs of the OCS Program. Channels deeper than 6-7 m accommodate an increasing numbers of ocean-going ships. The Corpus Christi, Houston, and Mississippi River ship channels are being considered for deepening to allow access by larger ocean-going vessels that are not related to the OCS Program. Increased population and commercial pressures on the Mississippi Coast are also causing pressures to expand ports there.

The COE, based on projected OCS activities, deepened access and interior channels of Port Fourchon, Louisiana, to greater than -7 m NGVD. The numbers of cargo vessels not related to petroleum or fishing, though, are projected to increase in the future. Materials dredged to deepen channels in Port Fourchon were used to create development sites and 192 ha of saline marsh. The COE feasibility report anticipates no significant saltwater intrusion effects on wetlands as a result of the deepening project, probably because the project only extends approximately 8.5 km inland and would be performed in a saline environment where the existing vegetation is salt tolerant (see **Chapter 4.2.1.3.2.**, Wetlands, for details).

Vessel traffic within navigation channels can cause channel bank erosion in wetland areas. **Tables 3-33 and 3-34** show vessel traffic using OCS-related waterways in 1999. A small percent of traffic using OCS-related channels is attributable to the OCS Program. Much of the lengths of these channels are through eroding canals, rivers, and bayous. . Maintenance dredging of existing channels would occur and could harm wetlands if the dredged material is deposited onto wetlands, resulting in burial or impoundment of marsh areas. This analysis assumes an increasing implementation of dredged material disposal for wetland enhancement and creation during the life of a proposed action. A small percentage of associated maintenance dredging of OCS-related channels and related impacts are attributed to the OCS Program. On average, every two years the COE surveys the navigation channels to determine the need for maintenance dredging. Schedules for maintenance dredging of OCS-related navigation channels vary broadly from once per year to once every 17 years. Each navigation channel is typically divided into segments called “reaches.” Each reach may have a maintenance schedule that is independent of adjacent reaches. The COE data indicates an approximate average of 14,059,500 m^3 per year or 492,082,500 m^3 per 35 years are displaced by maintenance dredging activities on OCS-related navigation channels in the GOM area; this roughly amounts to approximately 144,700 m^3 per kilometer.

Non-OCS-related navigation channels are believed to conduct lower traffic volumes and, therefore, are expected to widen at a lower rate (0.95 m/yr). In addition, these channels require less frequent maintenance dredging and are expected to produce 50 percent less dredged materials per kilometer. Hence, maintenance dredging of non-OCS-related channels is estimated to produce approximately 36,576,500 m^3 of material during the period 2003-2042. This dredged material could be used to enhance or re-establish marsh growth in deteriorating wetland areas. If implemented, the damaging effects of maintenance dredging of navigation channels would be reduced.

Significant volumes of OCS-related produced sands and drilling fluids would be transported to shore for disposal. According to USEPA information, sufficient disposal capacity exists at operating and proposed disposal sites. Because of current regulatory policies, no wetland areas would be disturbed as a result of the establishment of new disposal sites or expansions or existing sites, without adequate mitigation. Some seepage from waste sites may occur into adjacent wetland areas and result in damage to wetland vegetation.

Miscellaneous factors that impact coastal wetlands include marsh burning, marsh buggy traffic, onshore oil and gas activities, and well-site construction. Bahr and Wascom (1984) report major marsh burns that have resulted in permanent wetland loss. Sikora et al. (1983) reported that in one 16-km^2 wetland area in coastal Louisiana, 18.5 percent of the area was covered with marsh-buggy tracks. Tracks left by marsh buggies have been known to open new routes of water flow through relatively unbroken marsh, thereby inducing and accelerating erosion and sediment export. Marsh-buggy tracks are known to have persisted in Louisiana’s intermediate, brackish, and saline marshes for the past 15-30 years. Well-site construction activities include board roads and ring levees. Ring levees are approximately 1.6-ha impoundments constructed around a well site. In oil and gas fields, access canal spoil banks impound large areas of wetlands. The total acreage of impounded, dredged, and filled wetlands from drilling onshore coastal wells is considered substantial.

Current Mitigation Techniques Used to Reduce Adverse Impacts to Wetlands

Despite a national goal to achieve "no net loss of the . . . wetlands base," there is no one single law that protects wetlands (Strand, 1997). Instead, numerous regulatory mechanisms, combined with a well-defined mitigation process, are used to encourage wetland protection. The Clean Water Act Section 404 dredge and fill permit program is the strongest regulatory tool protecting wetlands from impacts; however, the key component of Section 404 is the requirement that adverse ecological impacts of a development project be mitigated by the developing agency (for OCS pipeline landfalls, this is the COE) or individual. The core of wetland protection revolves around the ability to mitigate or minimize impacts to wetlands and other sensitive coastal habitat.

Mitigation or the minimization of wetland impacts is particularly relevant along the GOM, specifically Louisiana, where significant impacts from human activities related to the oil and gas industry occur in wetland systems. As researchers document the direct and indirect consequences of pipelines, canals, dredging, and dredged material placement on wetland systems, optimizing old mitigation techniques and identifying new mitigation techniques in order to reduce impacts as much as possible is a necessary component of any development plan that terminates onshore. With more than 16,000 km (about 10,000 mi) of pipelines along the Gulf Coast (Johnson and Cahoon, in review), the extent to which activities related to these pipelines (and any new pipelines) are mitigated may be crucially important to the long-term integrity of the sensitive habitats (i.e., wetlands, shorelines, and seagrass communities) in these sensitive and fragile areas.

The following information identifies and documents the use and effectiveness of mitigation techniques related to OCS pipelines, canals, dredging, and dredged material placement in coastal GOM habitats. This information provides an overview and discussion of mitigation techniques that have been studied and used, as well as new and modified mitigation techniques that may not be well documented.

Mitigation Defined

The CEQ defined mitigation as a five-step process (1978):

(1) Avoidance – avoiding the impact altogether by not taking a certain action or part of an action;
(2) Minimization – minimizing of impacts by limiting the degree or magnitude of the action and its implementation;
(3) Restoration – rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
(4) Preservation through Maintenance – reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and
(5) Compensation – compensating for the impact by replacing or providing substitute resources of environments.

Mitigation History Related to Oil and Gas Activities

Mitigation of wetland impacts from oil and gas activities has a very short history. Prior to the 1980's, wetlands were not protected and very little attention was paid to the environmental impacts of pipeline construction within wetland areas. Focus was on deciding the best (most economical and fastest) way to install pipelines in soft sediment. With more recent requirements for considering impacts to sensitive coastal habitats, methods and techniques for mitigating impacts have been developed and refined. Because of the extensive coastal wetland systems along the GOM, avoidance of wetland systems is often impossible for pipelines related to OCS activities. Thus, minimization is the main focus of mitigation for pipeline-related activities.

Overview of Existing Mitigation Techniques and Results

Numerous suggestions for minimizing impacts have been recommended, with some of the most promising ideas emerging based on past experience and field observations. Depending on the location of the project in question and the surrounding environment, different mitigation techniques may be more appropriate than others. Based on permits, work documents, and interviews, 17 mitigation techniques have been identified as having been implemented at least once, with no one technique or suite of techniques routinely required by permitting agencies. Each pipeline mitigation process is uniquely designed to minimize damages given the particular setting and equipment to be installed. Of the identified mitigation techniques, a number of these are commonly required, while others are rarely used either because they are considered obsolete (in most instances) or they are applicable to only a narrow range of settings. **Table 4-52** highlights and summarizes technical evidence for the use of various mitigating processes associated with pipeline construction, canals, dredging, and dredged material placement.

Mitigation of impacts from OCS pipelines, canals, dredging, and dredged material placement has evolved with the growing environmental protection laws in the U.S. The "avoid, minimize, restore, and compensate" sequence has become an automatic series of events in project planning. Unfortunately, there is no quantitative, hard evidence of the reduction in impacts as a result of any one of the many mitigation techniques. Therefore, professional judgment remains the primary guide for decisionmakers.

The Coastal Impact Assistance Program (CIAP) has been authorized by Congress to assist states in mitigating the impacts associated with OCS oil and gas production. Congress has appropriated approximately $150 million to NOAA to be allocated to Texas and Louisiana, as well as five other coastal states. The money is to be used to undertake a variety of projects for protecting and restoring coastal resources and mitigating the impacts of OCS leasing and development. The Texas General Land Office and the Louisiana Department of Natural Resources are coordinating their State's efforts in acquiring their proportion of these funds.

In addition to the CIAP, the Gulf of Mexico Program (GMP) sponsors the Gulf Ecological Management Site (GEMS) program. The GEMS program is an initiative of the GMP and five Gulf States providing a framework for ecologically important GOM habitats. The GEMS program coordinates and utilizes existing Federal, State, local, and private programs, resources, and mechanisms to identify GEMS in each state. Each Gulf State has identified special ecological sites it regards as GEMS (**Table 4-51**).

Summary and Conclusion

Impacts from residential, commercial, and agricultural and silvicultural (forest expansion) developments are expected to continue in coastal regions around the GOM. Existing regulations and development permitting procedures indicate that development-related wetland loss may be slowed and that no new onshore OCS facilities, other than pipelines, would be constructed in wetlands.

Impacts from State onshore oil and gas activities are expected to occur as a result of dredging for new canals and maintenance, usage of existing rig access canals and drill slips, and preparation of new well sites. Indirect impacts from dredging new canals for State onshore oil and gas development (**Chapter 4.1.3.3.3.**, Dredging) and from maintenance of the existing canal network is expected to continue.

Maintenance dredging of the OCS-related navigation channels displaces approximately 492,082,500 m^3. Federally maintained, non-OCS-related navigation channels are estimated to account for another estimated 36,576,500 m^3 of dredged material. Maintenance dredging of inshore, well-access canals is estimated to result in the displacement of another 5,014,300 m^3 of materials. Insignificant adverse impacts upon wetlands from maintenance dredging are expected because the large majority of the material would be disposed upon existing disposal areas. Alternative dredged material disposal methods can be used to enhance and create coastal wetlands.

Depending upon the regions and soils through which they were dredged, secondary adverse impacts of canals can be much more locally significant and boarder than direct impacts. Additional wetland losses generated by the secondary impacts of saltwater intrusion, flank subsidence, freshwater-reservoir reduction, and deeper tidal penetration have not been calculated due to a lack of quantitative documentation; MMS has initiated a project to document and develop data concerning such losses. A variety of mitigation efforts are initiated to protect against direct and indirect wetland loss. The nonmaintenance of mitigation structures that reduce canal construction impacts can have substantial impacts upon wetlands. In Louisiana, deepening the Port Fourchon channels to accommodate larger, OCS-related service vessels has occurred within a saline marsh environment and presents the opportunity for the creation of wetlands with the dredged materials.

In conclusion, based on preliminary landloss results from the MMS/USGS NWRC current coastal pipeline impacts study for the Louisiana study area, the predicted landloss from the estimated 120-260 km of new OCS pipeline construction ranges from approximately 480-1,040 ha total over the 40 year analysis period. The MMS, in conjunction with the USGS, is continuing to develop models that will aid in quantifying habitat loss associated with OCS activities.

4.5.3.3. Seagrass Communities

This cumulative analysis considers the effects of impact-producing factors related to a proposed action, prior and future OCS activities, State oil and gas activities, other governmental and private activities, and pertinent natural processes and events that may adversely affect seagrass communities and associated habitat during the analysis period. The effects of canal dredging, scarring from vessel traffic, and oil spills on seagrass communities and associated habitat are described in **Chapters 4.2.1.3.3. and 4.4.3.3.** In addition to the above-stated impacts, other impact-producing factors (channelization) relevant to the cumulative analysis are discussed below.

Pipelines

Pipeline construction projects can affect seagrass habitats in a number of ways. Maintenance activities that disturb wetlands and associated habitat (submerged vegetation and seagrass beds), however, are very infrequent and considered insignificant. Pipeline installation methods and impacts to submerged vegetation are described in **Chapters 4.1.2.1.7., 4.2.1.3.3., and 4.4.3.3.** During reviews of pipeline projects for Federal and State permits, agencies consistently comment with concern upon the extent of secondary impacts. As a result, canal and pipeline construction permits require that structures be engineered to mitigate secondary adverse impacts. From 2003-2042, 70-120 new OCS pipelines are projected to enter State waters; of those, 23-38 pipelines are projected to result in landfalls.

Dredging, Channelization, and Water Controls

Dredge and fill activities are the greatest threats to submerged vegetation and seagrass habitat (Wolfe et al., 1988). Existing and projected lengths of OCS-related pipelines and OCS-related dredging activities are described in **Chapters 4.1.1.8.1. and 4.1.2.1.7.** The dynamics of how these activities impact submerged vegetation are discussed in **Chapter 4.2.1.3.3.** The most serious impacts to submerged vegetation and associated seagrass communities generated by dredging activities are a result of removal of sediments, burial of existing habitat, and oxygen depletion and reduced light attenuation associated with increased turbidity. Turbidity is most damaging to beds in waterbodies that are enclosed, have relatively long flushing periods, and contain bottom sediments that are easily resuspended for long periods of time. An integrative model of seagrass distribution and productivity produced by Dunton et al. (1998) strongly suggests that dredging operations that increases turbidity would negatively impact seagrass health because of light attenuation.

Dredging impacts associated with the installation of new navigation channels are greater than those for pipeline installations because new canal dredging creates a much wider and deeper footprint. A greater amount of material and fine materials are disturbed; hence, turbidity in the vicinity of canal dredging is much greater, persists for longer periods of time, and the turbidity extends over greater distances and acreage. New canals and related disposal of dredged material also cause significant changes in regional hydrodynamics and associated erosion. Significant and substantial secondary impacts include wake erosion resulting from navigational traffic. This is evident along the Texas coast where heavy traffic utilizing the GIWW has accelerated erosion of existing salt marsh habitat (Cox et al., 1997).

New channel dredging within of the activity area has impacted lower-salinity species of submerged vegetation and seagrass communities in Louisiana and Texas the most. This would continue to be the case in the foreseeable future. Similarly, most impacts to higher-salinity species of submerged vegetation have occurred in Florida, where seagrass beds are more abundant. Reduction of submerged vegetation in the bays of Florida is largely attributed to increased turbidity, which is primarily due to dredge and fill activities (Wolfe et al., 1988). Channel dredging to facilitate, create, and maintain waterfront real estate, marinas, and waterways would continue to be a major impact-producing factor in the proposed cumulative activity area.

The waterway maintenance program of the COE has been operating in the cumulative activity area for decades. Impacts generated by initial channel excavations are sustained by regular maintenance activities performed every 2-5 years, sometimes less frequently. The patterns of submerged vegetation and seagrass beds have adjusted accordingly. Maintenance activities are projected to continue into the future regardless of OCS activities. If the patterns of maintenance dredging change, then the patterns of submerged vegetation distribution may also change.

In areas where typical spoil banks are used to store dredged materials, the usual fluid nature of mud and subsequent erosion causes spoil bank widening, which may bury nearby waterbottoms and submerged vegetation/seagrass beds. Those waterbottoms may become elevated, converting some nonvegetated waterbottoms to shallower waterbottoms that may become vegetated due to increased light at the new soil surface. Some of these waterbottoms may also be converted to wetlands, or even uplands, by the increased elevation.

Plans for installation of new linear facilities and maintenance dredging are reviewed by a variety of Federal, State, and local agencies, as well as by the interested public for the purposes of receiving necessary government approvals. Mitigation may be required to reduce undesirable impacts. Using turbidity curtains can control turbidity. The most effective mitigation for direct impacts to seagrass beds and associated habitat, though, is avoidance with a wide berth around them.

Many of man's activities have caused landloss either directly or indirectly by accelerating natural processes. Until the Mississippi River was channelized and leveed during the early 1900's, floodwaters layered sediment over the active deltaic plain, countering ongoing submergence and building new land. Areas that did not receive sediment-laden floodwaters lost elevation. Human intervention (channelization and leveeing), though, interrupted this process of renewal. In addition, the Mississippi River's suspended sediment load has decreased more than 50 percent since the 1950's, largely as a result of dam and reservoir construction (Turner and Cahoon, 1988) and soil conservation practices in the drainage basin. Also, construction of the GIWW and other channelization projects associated with its development has severely altered natural drainage patterns along many areas of the Texas coast. Furthermore, saltwater intrusion, as a result of river channelization and canal dredging, has caused coastal habitat deterioration (including seagrass communities) (Tiner, 1984; National Wetlands Inventory Group, 1985). Productivity and species diversity associated with submerged vegetated habitat in coastal marshes of Louisiana and Texas is greatly reduced by saltwater intrusion (Stutzenbaker and Weller, 1989).

Leveeing (or banking) and deepening of the Mississippi River has affected seagrass communities in the Mississippi and Chandeleur Sounds by reducing freshwater flows and flooding into those estuaries and by raising their average salinity. Due to increased salinity, some species of submerged vegetation, including seagrass beds, are able to populate farther inland where sediment conditions are not as ideal. If the original beds are then subjected to salinities that are too high for their physiology, the vegetation would die, thus affecting the habitat associated with the seagrass beds (e.g., nursery habitat for juvenile fish and shrimp). In turn, rivers that have been modified for flood control have an increase of freshwater inflow near their entrance; hence, beds of submerged vegetation may become established farther seaward if conditions are favorable. If the original beds are then subjected to salinities that are too low for their physiology, the vegetation would die. These adjustments have occurred in the cumulative activity area, particularly when high-water stages in the Mississippi River cause the opening of the Bonnet Carre′ Spillway to divert floodwaters into Lake Pontchartrain. This freshwater eventually flows into the Mississippi and Chandeleur Sounds, lowering salinities. In the past, spillway openings have been associated with as much as a 16 percent loss in seagrass vegetation acreage (Eleuterius, 1987). Conversely, the Caernarvon Freshwater Diversion into the Breton Sound Basin, east of the Mississippi River, has reduced average salinities in the area. The reduced salinities have triggered a large increase in submerged freshwater vegetation acreage. Seagrass communities may thus reestablish in regions that were previously too saline for them.

Scarring

The scarring of seagrass beds by vessels (including various support vessels for OCS and State oil and gas activities, fishing vessels, and recreational watercraft) is an increasing concern along the Gulf Coast, especially in Texas and Florida where the majority of seagrass occurs. Scarring most commonly occurs in seagrass beds that occur in water depths shallower than 6 ft as a result of boats of all classes operating in water that is too shallow for them. Consequently, their propellers and occasionally their keels plow though shallow water bottoms, tearing up roots, rhizomes, and whole plants, leaving a furrow devoid of seagrasses, ultimately destroying essential nursery habitat. Other causes of scarring include anchor dragging, trawling, trampling, and loggerhead turtles foraging especially in Florida's coastal seagrass habitats (Sargent et al., 1995; Preen, 1996). Scarring may have a more critical effect on habitat functions in areas with less submerged vegetation. The Panhandle area, west of Cape San Blas, Florida, has fewer acres of seagrasses and has had little to moderate to severe scarring of its seagrass beds.

Recently, seismic activity in areas supporting seagrass nursery habitat has become a focus of concern for Texas State agencies. Although the greatest scarring of seagrasses has resulted from smaller boats operating in the vicinities of the greatest human population and boat registration densities, the greatest single scars have resulted from commercial vessels. A few local governments of the Florida Panhandle and the Coastal Bend of Texas have instituted management programs to reduce scarring. These programs include education, channel marking, increased enforcement, and limited-motoring zones. Initial results indicate that scarring can be reduced.

Oil Spills

Because of the floating nature of oil and the regional microtidal range, oil spills alone would typically have very little impact on seagrass communities and associated epifauna. Increased wave action can increase impacts to submerged vegetation and the community of organisms that reside in these beds by forcing oil from the slick into the water column. Unusually low tidal events would also increase the risk of oil having direct contact with the vegetation. Even then, epifauna residing in these seagrass beds would be more heavily impacted than the vegetation itself. Oiling of seagrass beds would result in die-back of the vegetation and associated epifauna, which would be replaced for the most part in 1-2 growing seasons, depending upon the season in which the spill occurs. Although little or no direct mortality of seagrass beds is expected as a result of oil-spill occurrences, contact of seagrasses with crude or refined oil products has been implicated as a causative factor in the decline of seagrass beds and in the observed changes in species composition within them (Eleuterius, 1987). The cleanup of slicks in shallow, protected waters (less than 5 ft deep) can cause significant scarring and trampling of submerged vegetation beds.

Oil spilled in Federal offshore waters is not projected to significantly impact submerged aquatic vegetation, which includes seagrass communities. In contrast, oil spills from inland oil-handling facilities and navigational traffic have a greater potential for impacting wetlands and seagrass communities based on information presented in **Chapter 4.1.2.1.5.1.**, Pipeline Shore Facilities. Given the large number of existing oil wells and pipelines in eastern coastal Louisiana and the volumes of oil piped through that area from the OCS, the risk of oil-spill contacts to the few seagrass beds in that vicinity would be much higher than elsewhere in the cumulative activity area.

Summary and Conclusion

Dredging generates the greatest overall risk to submerged vegetation. Dredging causes problems for beds of submerged vegetation. These actions uproot, bury, and smother plants as well as decrease oxygen in the water; and reduce the amount of necessary sunlight. Channel dredging to create and maintain waterfront real estate, marinas, and waterways would continue to cause the greatest impacts to higher salinity submerged vegetation.

The oil and gas industry and land developers perform most of the new dredging in the cumulative activity area. Most dredging that impacts lower salinity submerged vegetation has occurred in Louisiana and Texas in support of inshore petroleum development. Cumulatively, offshore oil and gas activities are projected to generate 19-32 pipeline landfalls in Texas and Louisiana. Mitigation may be required to reduce undesirable impacts of dredging to submerged vegetation. Maintenance dredging of navigation channels may sustain the impacts of original dredging. The most effective mitigation for direct impacts to submerged vegetation beds is avoidance, as well as the use of turbidity curtains to reduce turbid conditions.

Large water-control structures associated with the Mississippi River influence salinities in coastal areas, which in turn influence the location of seagrass communities and associated epifauna. Where flooding or other freshwater flow to the sea is reduced, regional average salinities generally increase. Average salinities in areas of the coast that receive increased freshwater flows are generally reduced. Beds of submerged vegetation (seagrass) adjust their locations based on their salinity needs. If the appropriate salinity range for a species is located where other environmental circumstances are not favorable, the new beds would be either smaller, less dense, or may not colonize at all.

When the Mississippi River is in flood condition, floodways may be opened to alleviate the threat of levee damage. These floodways direct water to estuarine areas where floodwaters may suddenly reduce salinities for a couple of weeks to several months. This lower salinity can damage or kill high-salinity seagrass beds if low salinities are sustained for longer periods than the seagrass species can tolerate. Opening a floodway is the one action that can adversely impact the largest areas of higher-salinity submerged vegetation.

Inshore oil spills generally present greater risks of adversely impacting submerged vegetation and seagrass communities than do offshore spills (**Chapter 4.4.3.3.**). The risk of coastal spills occurring from operations that support OCS activities would also be widely distributed in this coastal area, but the risk would primarily be focused in the two areas receiving the largest volume of OCS-generated oil—the Houston/Galveston area of Texas and the deltaic area of Louisiana. Oil-spill contact would result in die-back to the seagrass vegetation and supported epifauna, which would be replaced for the most part within 1-2 growing seasons, depending upon the season in which the spill occurs. Although zero to little direct permanent mortality of seagrass beds is expected as a result of oil-spill occurrences, contact of seagrasses with crude and refined oil has been implicated as a causative factor in the decline of seagrass beds and in the observed changes in species composition within them (Eleuterius, 1987).

Because of the floating nature of oil and the microtidal range that occurs in this area, oil spills alone would typically have very little impact on seagrass beds and associated epifauna. Unusually low tidal events, increased wave energy, or the use of oil dispersants increase the risk of impact. Usually, epifauna residing within the seagrass beds is much more heavily impacted than the vegetation. The cleanup of slicks in shallow, protected waters less than 5-ft deep can cause significant scarring and trampling of submerged vegetation and seagrass beds.

Seagrass communities and associated habitat can be scarred by anchor dragging, trampling, trawling, loggerhead turtles, occasional seismic activity, and boats operating in water that is too shallow for their keels or propellers. These actions remove or crush plants. The greatest scarring results from smaller boats operating in the vicinities of larger populations of humans and registered boats. A few State and local governments have instituted management programs that have resulted in reduced scarring.

In general, a proposed action would cause a minor incremental contribution to impacts to submerged vegetation due to dredging, boat scarring, pipeline installations and possibly oil spills. Because channel maintenance, land development, and flood control would continue, with only minor impacts attributable to OCS activities, a proposed action would cause no substantial incremental contribution to these activities or to their impacts upon submerged aquatic vegetation or seagrass communities.

4.5.4. Impacts on Sensitive Offshore Benthic Resources

4.5.4.1. Continental Shelf Resources

4.5.4.1.1. Live Bottoms (Pinnacle Trend)

The pinnacle trend is located northwest of the proposed lease sale area, where pipelines may be constructed to support a proposed action. This cumulative analysis considers the effects of impact-producing factors related to a proposed action plus those related to prior and future OCS lease sales, and to tanker and other shipping operations that may occur and adversely affect live bottoms (low-relief and pinnacle trend features). Specific OCS-related, impact-producing factors considered in the analysis are structure emplacement and removal, anchoring, discharges from well drilling, produced waters, pipeline emplacement, oil spills, blowouts, and operational discharges by tanker ships. Non-OCS-related impact-producing factors have the potential to alter live bottoms. These factors include commercial fisheries, natural disturbances, additional anchoring by recreational boats and other non-OCS commercial vessels, as well as spillage from import tankering.

Since the pinnacle trend area is not within the proposed lease sale area, it is assumed that protective stipulations for live bottoms and the pinnacle trend features would be part of OCS leases that could be affected by pipeline construction to support a proposed action. Stipulations and mitigations require operators to do the following:

- locate potential individual live bottoms and associated communities that may be present in the area of proposed activities and,
- protect sensitive habitat potentially impacted by OCS activities by requiring appropriate mitigation measures.

Stipulations and mitigations do not protect the resources from activities outside MMS jurisdiction (i.e., commercial fishing, tanker and shipping operations, or recreational activities).

Most non-OCS activities have a greater potential to affect the hard-bottom communities of the region. Recreational boating and fishing, import tankering, and natural events such as extreme weather and fluctuations of environmental conditions (e.g., nutrient pulses, low dissolved oxygen levels, seawater temperature minima, and seasonal algal blooms) may severely impact low relief, live bottom communities associated with the pinnacle trend area of the CPA and EPA. In addition, ships anchoring near major shipping fairways, on occasion, may impact sensitive areas located near these fairways. Numerous fishermen take advantage of the relatively shallow and easily accessible resources of the region and anchor on and around hard-bottom habitat in order to fish, particularly in the pinnacle trend area. Therefore, several instances of severe and permanent physical damage to the pinnacle features and the associated live bottoms could occur from non-OCS activities. It is believed that biota associated with live bottoms of the pinnacle trend area are well adapted to many of the natural disturbances mentioned above. A severe human disturbance, however, could cause serious damage to live-bottom biota, possibly leading to changes of physical integrity, species diversity, or biological productivity exceeding natural variability. If such an event were to occur, recovery to pre-impact conditions could take as long as 10 years.

In addition to anchoring, the emplacement of drilling rigs and production platforms on the seafloor compresses the organisms directly beneath the legs or mat used to support the structure. The areas affected by the placement of the rigs and platforms would predominantly be soft-bottom regions where the infaunal and epifaunal communities are ubiquitous. Because of local bottom currents, the presence of conventional bottom-founded platform structures can cause scouring of the surficial sediments (Caillouet et al., 1981).

Structure placement and anchor damage from support boats and ships, floating drilling units, and pipeline-laying vessels disturb areas of the seafloor. These disturbances are considered the greatest OCS-related threat to live-bottom areas. The size of the areas affected by chains associated with anchors and pipeline-laying barges would depend on the water depth, chain length, sizes of anchor and chain, method of placement, and wind and current speed and direction. Anchor damage includes but is not limited to crushing and breaking of live/hard bottoms and associated communities. Anchoring often destroys a wide swath of habitat when a vessel drags or swings an anchor causing the anchor and chains to drag the seafloor. The biological stipulations limit the proximity of new activities relevant to live bottoms and sensitive features. Platforms are required to be placed away from live bottoms, thus, anchoring events near platforms are not expected to impact the resource. Accidental anchoring could severely impact hard-bottom substrate with recovery rates (which are not well documented) estimated at 5-20 years depending on the severity.

Both explosive and nonexplosive structure-removal operations disturb the seafloor and can potentially affect nearby live/hard-bottom communities. Structure removals using explosives is the most common removal method in the GOM, but would not be used in the proposed lease sale area. Since biological stipulations limit the proximity of structures to relevant live bottoms and sensitive features, explosive removals are not expected to affect these sensitive areas. Should low-relief, hard-bottom communities incur any damages as a result of the explosive removal of structures, impacts would include restricted cases of mortality, and the predicted recovery to pre-impact conditions would be accomplished in less than 10 years.

Routine discharges of drilling muds and cuttings by oil and gas operations could affect biological communities (EFH is discussed in **Chapter 4.5.10.**) and organisms through a variety of mechanisms, including the smothering of organisms through deposition or less obvious sublethal toxic effects (impacts to growth and reproduction). The protective lease stipulations and site-specific mitigations would prevent drilling activities and drilling discharges from occurring directly over pinnacle features or associated habitat. Drilling discharges should reach undetectable concentrations in the water column within 1,000 m of the discharge point, thus limiting potential toxic effects to any benthic organisms occurring within a 1,000-m radius from the discharge point. Any effects would be expected to diminish with increasing distance from the discharge area. Although Shinn et al. (1993) found detectable levels of metals from muds out to 1,500 m from a previously drilled well site in the pinnacle trend area, the levels of these contaminants in the water column and sediments are expected to be much lower than those known to have occurred in the past, due to new USEPA discharge regulations and permits **(Chapter 4.1.1.4.**, Operational Waste Discharged Offshore). Regional surface currents and the water depth (>40 m) would greatly dilute the effluent. Deposition of drilling muds and cuttings in live-bottom and pinnacle trend areas are not expected to greatly impact the biota of the pinnacles or the surrounding habitat. Furthermore, because the biota of the seafloor surrounding the pinnacles are adapted to life in turbid (nepheloid) conditions and high sedimentation rates in the western portions of the pinnacle trend area, deposition and turbidity caused by a nearby well should not adversely affect this sensitive environment. The impact from muds and cuttings discharged as a result of the cumulative scenario would be temporary, primarily sublethal in nature, and the effects would be limited to small areas. Recovery to pre-impact conditions from these sublethal impacts would take place within 10 years.

The depth of the low relief hard bottoms (>40 m), currents, and offset of discharges of produced waters and domestic and sanitary wastes (required by lease stipulations and postlease mitigations) would result in the dilution of produced waters and wastes to harmless levels before reaching any of the live bottom. Adverse impacts from discharges of produced waters and domestic and sanitary wastes as a result of the cumulative case would therefore be temporary, primarily sublethal in nature, and the effects would be limited to small areas. Predicted recovery to pre-impact conditions from these sublethal impacts would take place within 5 years.

The Live Bottom (Low Relief) Stipulation, Eastern Pinnacle Trend Stipulation, and site-specific mitigations are expected to prevent operators from placing pipelines directly upon live-bottom communities. The effect of pipeline-laying activities on the biota of these communities would be restricted to the resuspension of sediments, possibly causing obstruction of filter-feeding mechanisms of sedentary organisms and gills of fishes. Adverse impacts from resuspended sediments would be temporary, primarily sublethal in nature, and the effects would be limited to small areas. Predicted recovery to pre-impact conditions from these sublethal impacts would take place within 5 years.

Assumptions of oil-spill occurrences, spill sizes, and estimates resulting from the OCS Program are described in **Chapters 4.3.1.1.1.1. and 4.3.1.1.1.2.** Oil spills have the potential to be driven into the water column. Measurable amounts have been documented down to a 10-m depth, although modeling exercises have indicated such oil may reach a depth of 20 m. At this depth, however, the concentration of the spilled oil or dispersed oil would be at several orders of magnitude lower than the amount shown to have an effect on marine organisms (Lange, 1985; McAuliffe et al., 1975 and 1981). Recovery capabilities from a catastrophic scenario, such as the unlikely event a freighter, tanker, or other ocean going vessel related to OCS Program activities sank and proceeded to collide with the pinnacle features or associated habitat releasing its cargo, are unknown at this time.

For the purpose of this analysis, it is projected that no surface spills, regardless of size, would have an impact on the biota of live/hard bottoms, largely because the tops of the features crest at depths greater than 20 m. Surface oil spills are therefore not expected to impact the hard-bottom communities.

Subsurface pipeline oil spills are not expected to cause damage to live/hard-bottom biota because the oil would initially adhere to the sediments surrounding the buried pipeline until the sediment reached its maximum capacity to retain the oil before the oil rapidly rises (typically 100 m/hr in shallow water) (Guinasso, personal communication, 1997) in discrete droplets toward the sea surface. Oil-spill occurrence for the OCS Program is presented in **Chapter 4.3.1.1.1.**, Past Spill Incidents. Since the lease stipulations and site-specific mitigations would prevent the installation of pipelines in the immediate vicinity of live/hard-bottom areas, there is little probability that a subsurface oil spill would impact live/hard bottoms. Should a pipeline spill occur in the immediate vicinity of a live/hard bottom, impacts, including the uptake of hydrocarbons and attenuated incident light penetration, could cause partial or even total mortality of local biota depending on the severity of the accident. Much of the biota, however, would likely survive and recover once the live/hard bottoms were clear of oil. The adverse impacts from subsurface oil spills on live/hard bottoms would be minor in scope, primarily sublethal in nature, and the effects would be contained within a small area. Recovery to pre-impact conditions from these sublethal impacts could take place within 5-10 years.

Blowouts have the potential to resuspend sediments and release hydrocarbons into the water column, which may affect pinnacle-trend communities. Subsurface blowouts occurring near these communities can pose a threat to the biota, however, the severity and proximity of such an occurrence to live/hard bottoms cannot be predicted. Depending upon the severity of the occurrence of a blowout in close proximity to a pinnacle-trend community, the damage could be catastrophic and irreversible. What can be predicted is that such blowouts would, at minimum, cause sediments to be released and resuspended. A severe subsurface blowout within 400 m of a live/hard bottom could result in the smothering of the biota due to sedimentation. Since much of the live/hard-bottom biota is adapted to turbid conditions, most impacts would probably be sublethal with recovery taking place within approximately 5 years. The continued implementation of lease stipulations and mitigations should prevent blowouts from occurring directly on or in proximity to live/hard bottoms

Should the Live Bottom (Low Relief) and Pinnacle Trend Stipulations not be implemented for future lease sales, OCS activities could have the potential to destroy part or all of the biological communities and damage one or several live/hard-bottom features. The most potentially damaging of these are the impacts associated with physical damages resulting from anchors, structure emplacement, and other bottom-disturbing operations. Potential impacts from oil spills larger than 1,000 bbl, blowouts, pipeline emplacement, mud and cutting discharges, and structure removals exist. The OCS Program, without the benefit of protective lease stipulations and site-specific mitigations, would probably have an adverse impact on live/hard bottoms in the EPA, particularly from anchor damage to pinnacle-trend features.

Summary and Conclusion

Non-OCS activities in the vicinity of the hard-bottom communities include recreational boating and fishing, import tankering, and natural events such as extreme weather conditions, and extreme fluctuations of environmental conditions (e.g., nutrient pulses, low dissolved oxygen levels, seawater temperature minima, and seasonal algal blooms). These activities could cause severe damage that would threaten the survival of the live/hard-bottom communities. Ships using fairways in the vicinity of live/hard bottoms anchor in the general area of live/hard bottoms on occasion, and numerous fishermen take advantage of the relatively shallow and easily accessible resources of regional live/hard bottoms. These activities could lead to several instances of severe and permanent physical damage.

Impact-producing factors resulting from routine activities of OCS oil and gas operations include physical damage, anchoring, structure emplacement and removal, pipeline emplacement, drilling discharges, discharges of produced waters, and discharges of domestic and sanitary wastes. In addition, accidental subsea oil spills or blowouts associated with OCS activities can cause damage to live bottoms. Long-term OCS activities are not expected to adversely impact the live/hard-bottom environment if these impact-producing factors are restrained by the continued implementation of protective lease stipulations and site-specific mitigations. The Live Bottom (Low Relief) and Eastern Pinnacle Trend Stipulations would preclude the occurrence of physical damage, the most potentially damaging of these activities. The impacts to the live/hard bottoms are judged to be infrequent because of the small number of operations in the vicinity of live/hard bottoms. The impact to the live/hard-bottom resource as a whole is expected to be slight because of the projected lack of community-wide impacts.

Impacts from blowouts, pipeline emplacement, muds and cuttings discharges, other operational discharges, and structure removals should be minimized because of the Live Bottom (Low Relief) and Eastern Pinnacle Trend Stipulations, and the dilution of discharges and resuspended sediments in the area. Potential impacts from discharges would probably be further reduced by USEPA discharge regulations and permits restrictions (**Chapter 4.1.1.4.**). Potential impact from oil spills ≥1,000 bbl would be restricted because of the depth of the features (>20 m) (if the spill occurs on the sea surface), because subsea pipeline spills are expected to rise rapidly, and because of the low prospect of pipelines being routed immediately adjacent to live/hard bottoms. The frequency of impacts to live/hard bottoms should be rare and the severity slight. Impacts from accidents involving anchor placement on live/hard bottoms could be severe in small areas (those actually crushed or subjected to abrasions).

The incremental contribution of a proposed action (as analyzed in **Chapters 4.2.1.4.1.1. and 4.4.4.1.1.**) to the cumulative impact on live/hard bottoms is expected to be slight, with possible impacts from physical disturbance of the bottom from pipeline emplacement, and oil spills. Negative impacts should be restricted by the implementation of the Live Bottom (Low Relief) and Eastern Pinnacle Trend Stipulations and site-specific stipulations on existing and future leases in the pinnacle trend area, the depths of the features, the currents in the live/hard-bottom area, and distance from the proposed lease sale area.

4.5.4.2. Continental Slope and Deepwater Resources

Cumulative factors considered to impact the deepwater benthic communities of the GOM include both oil- and gas-related and non-oil- and gas-related activities. The latter type of impacting factors includes activities such as fishing and trawling. There are essentially only two species considered important to deepwater bottom fisheries—yellowedge grouper and tilefish. The yellowedge grouper's habitat only extends to about 275 m, while the tilefish's habitat extends to 411 m. Therefore, these species would not occur in a proposed lease sale area due to the fact that the shallowest water depth is 1,600 m. De Forges et al. (2000) report threats to deepwater biological communities by fishing activity off New Zealand. Species similar to the targeted species in Australia and New Zealand, the orange roughy (genus *Hoplostethus*), do occur in the GOM; however, they are not abundant and are smaller in size. Bottom fishing and trawling efforts in the proposed lease sale area are essentially nonexistent; consequently, impacts to deepwater benthic communities from non-oil- and gas-related activities are negligible.

Oil- and gas-related activities include pipeline and platform emplacement activities, anchoring, accidental seafloor blowouts, and drilling discharges. This analysis considers the effects of these factors related to a proposed action and to future OCS lease sales.

Other sources of cumulative impact to deepwater benthic communities would be possible, but are considered unlikely to occur. No anchoring from non-OCS-related activities occurs at the water depths where these communities are found. Some impacts are highly unlikely yet not impossible, such as the sinking of a ship or barge resulting in collision or contaminant release directly on top of a high-density community. One potential significant source of impact would be carbon sequestration in the deep sea as recently proposed by some international groups as a technique to reduce atmospheric carbon dioxide. Boyd et al. (2000) reported the successful iron fertilization of the polar Southern Ocean resulting in a large drawdown of carbon dioxide for at least 13 days and a massive plankton bloom for 30 days. Recent papers have highlighted the potential serious consequences of large scale CO_2 sequestration. Seibel and Walsh (2001) report extensive literature on the physiology of deep-sea biota indicating that they are highly susceptible to the CO_2 and pH excursions likely to accompany deep-sea CO_2 sequestration. The impacts of even very small excursions of pH and CO_2 could have serious, even global, deep-sea ecosystem impacts. Substantial additional research is needed before any large-scale actions would take place.

The greatest potential for adverse impacts to occur to the deepwater benthic communities, both chemosynthetic and nonchemosynthetic, would come from those OCS-related, bottom-disturbing activities associated with pipeline and platform emplacement (including templates and subsea completions), associated anchoring activities, discharges of muds and cuttings, and seafloor blowout accidents. The potential impacts to deepwater benthic communities from these activities are discussed in detail in **Chapters 4.2.1.4.2.** The potential impacts from seafloor blowout accidents are discussed in **Chapter 4.4.4.2.**

As exploration and development continue on the Federal OCS, activities have moved into the deeper water areas of the GOM. With this trend comes the certainty that increased development would occur on potentially productive discoveries throughout the entire depth range of the proposed lease sale area; these activities would be accompanied by impacts to the deepwater benthos from bottom disturbances and disruption of the seafloor from associated activities. The extent of these disturbances would be determined by the intensity of development in these deepwater regions, the types of structures and mooring systems used, and the effective application of the avoidance criteria required under NTL 2000-G20. Activity levels for the cumulative scenario in the EPA are projected (**Table 4-4**). For the EPA deepwater offshore Subareas E1600-2400 and E>2400, an estimated 14-29 and 24-44 exploration and delineation wells and 25-55 and 35-81 development wells respectively are projected to be drilled. A total of 4-7 production structures are projected to be installed in deepwater through the years 2003-2042.

Routine discharges of drilling muds and cuttings have been documented to reach the seafloor in water depths greater than 400 m (discussed in **Chapter 4.2.1.4.2.**), but these discharges are distributed across wider areas and in thinner accumulations than they would be in shallower water depths. Potential impacts could result from accumulations of muds and cuttings resulting from consistent hydrographic conditions and drilling of multiple wells from the same location causing concentrations of material in a single direction or "splay." It is not expected that detectable levels of muds and cuttings discharges from separate developments or from adjacent lease blocks would act as a cumulative impact to deepwater benthic communities due their physical separation and great water depths.

An MMS-funded study, entitled *Effects of Oil and Gas Exploration and Development at Selected Continental Slope Sites in the Gulf of Mexico*, would further refine the effectiveness of the new avoidance criteria. An additional study, *Improving the Predictive Capability of 3-D Seismic Surface Amplitude Data for Identifying Chemosynthetic Community Sites*, has also recently begun and is intended to groundtruth the interpretation of geophysical 3D seismic surface anomaly data and the relationship to expected or potential community sites. The results of these studies would be used to refine the existing exploratory or development plans biological review processes, if needed, as soon as results are available.

The majority of deepwater chemosynthetic communities are of low density and are widespread throughout the deepwater areas of the GOM. Low-density communities may occasionally sustain minor impacts from discharges of drill muds and cuttings or resuspended sediments. These impacts are most likely to be sublethal in nature and would be limited in areal extent. The frequency of such impact is expected to be low. Physical disturbance to a small area would not result in a major impact to the ecosystem. The consequences of these impacts to these widely distributed low-density communities are considered to be minor with no change to ecological relationships with the surrounding benthos.

High-density, Bush Hill-type communities are widely distributed but few in number and limited in size. They have a high standing biomass and productivity. High-density, chemosynthetic communities would be largely protected by NTL 2000-G20, which serves to prevent impacts by requiring avoidance of potential chemosynthetic communities identified by association with geophysical characteristics or by requiring photodocumentation to establish the presence or absence of chemosynthetic communities prior to approval of the structure or anchor placements. Current implementation of these avoidance criteria and understanding of potential impacts indicate that high-density communities should be protected from burial by pre-riser discharges of muds and cuttings at the bottom and burial by muds and cuttings discharges from the surface. It is not known if there are any low-density or high-density communities in the proposed lease sale area.

Small impacts are expected to occur infrequently, but the impacts from bottom-disturbing activities, if they occur, could be quite severe to the immediate area affected. If it occurred, the disturbance of a Bush Hill-type environment could lead to the destruction of a community from which recovery would occur only over long intervals (200+ years for a mature tube-worm colony and 25-50 years for a mature mussel community) or would not occur at all. The severity of such an impact is such that there may be incremental losses of productivity, reproduction, community relationships, overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

In cases where high-density communities are subjected to greatly dispersed discharges or resuspended sediments, the impacts are most likely to be sublethal in nature and limited in areal extent. The impacts to ecological function of high-density communities would be minor with recovery occurring within 2 years; however, minor impacts to ecological relationships with the surrounding benthos would also be likely.

Because of the great water depths, sanitary wastes and produced waters are not expected to have adverse impacts to any deepwater benthic communities. These effluents would undergo a great deal of dilution and dispersion before reaching the bottom, if ever.

A blowout at the seafloor could resuspend large quantities of bottom sediments and even create a large crater, destroying any organisms in the area. Structure removals and other bottom-disturbing activities could resuspend bottom sediments, but not at magnitudes as great as blowout events. The distance of separation provided by the adherence of NTL 2000-G20 would protect both chemosynthetic and nonchemosynthetic communities from the direct effects of deepwater blowouts. Subsea structure removals are not expected in water depths greater than 800 m, in accordance with 30CFR 250, which includes all of the proposed lease sale area.

Oil and chemical spills (potentially from non-OCS-related activities) are not considered to be a potential source of measurable impacts on chemosynthetic communities (or nonchemosynthetic deepwater communities) because of the water depth. Oil spills from the surface would tend not to sink. Oil discharges at depth or on the bottom would tend to rise at least some distance in the water column and similarly not impact the benthos. There is also reason to expect that chemosynthetic animals are resistant to at least low concentrations of dissolved hydrocarbons in the water, as communities are typically found growing near oil saturated sediments and in the immediate vicinity of active oil and gas seeps.

Deepwater coral and other hard-bottom communities not associated with chemosynthetic communities are also expected to be protected by general adherence to NTL 2000-G20 and the shallow hazards NTL 98-12 due to the avoidance of areas represented as hard bottom on surface anomaly maps derived from 3D seismic records. Biological reviews are performed on all activity plans (E&P). Reviews include analysis of maps for hard bottom areas that are generally avoided because they are one of several important indicators for the potential presence of chemosynthetic communities.

Summary and Conclusion

Impacts to deepwater communities in the GOM from sources other than OCS activities are considered negligible. Activities unrelated to the OCS Program include fishing and trawling. Because of the water depths in the proposed lease sale area and the lack of commercially valuable fishery species, these activities are not expected to impact deepwater benthic comminutes. The most serious impact-producing factor threatening chemosynthetic communities is physical disturbance of the seafloor, which would destroy the organisms of these communities. Such disturbance would most likely come from those OCS-related activities associated with pipelaying, anchoring, structure emplacement, and seafloor blowouts. Drilling discharges and resuspended sediments have a potential to cause minor, mostly sublethal impacts to chemosynthetic communities, but substantial accumulations could result in more serious impacts. Seafloor disturbance is considered to be a threat only to the high-density (Bush Hill-type) communities; the widely distributed low-density communities would not be at risk. The provisions of NTL 2000-G20 would greatly reduce the risk. The NTL requires surveys and avoidance of potential community areas prior to drilling. In addition, new studies are currently refining the information and confirming the effectiveness of these provisions.

The activities considered under the cumulative scenario are expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities could experience minor impacts from drilling discharges or resuspended sediments, with recovery expected within several years. If physical disturbance (such as anchor damage) or extensive burial by muds and cuttings were to occur to high-density, Bush Hill-type communities, impacts could be severe, with recovery time as long as 200 years for mature tube-worm communities. There is evidence that substantial impacts on these communities would permanently prevent reestablishment. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos. It is not known if there are any chemosynthetic communities in the proposed lease sale area.

The cumulative impacts on nonchemosynthetic benthic communities are expected to cause little damage to the ecological function or biological productivity of the expected typical communities existing on sand/silt/clay bottoms of the deep GOM. Large motile animals would tend to move, and recolonization from populations from neighboring substrates would be expected in any areas impacted by burial. Deepwater coral or other high-density, hard-bottom communities are also not known to exist in the proposed lease sale area. However, similar to potential chemosynthetic communities, the cumulative impacts on any potential hard-bottom communities are expected to cause little damage to ecological function or biological productivity.

The incremental contribution of a proposed action (as analyzed in **Chapters 4.2.1.4.2. and 4.4.4.2.**) to the cumulative impact on deepwater benthic communities is expected to be slight, and to result from the effects of the possible impacts caused by physical disturbance of the seafloor and minor impacts from sediment resuspension. Adverse impacts would be limited but not completely eliminated by adherence to NTL 2000-G20.

4.5.5. Impacts on Marine Mammals

This cumulative analysis considers activities that have occurred or may occur and adversely affect marine mammals in the same general area that may be affected by a proposed action. The combination of potential impacts resulting from a proposed action in addition to past, present, and future OCS activities, incidental take in fisheries, live captures and removals, anomalous mortality events, habitat alteration, and pollution may affect marine mammals (endangered, threatened, and/or protected) in the region. The impacts relative to a proposed action are described in **Chapter 4.2.1.5.** Sections providing supportive material for the marine mammals' analysis include **Chapters 3.2.3.** (Marine Mammals), **4.1.1.2.** (Exploration and Delineation), **4.1.1.3.** (Development and Production), **4.1.2.1.** (Coastal Infrastructure), and **4.3.1.** (Oil Spills).

Information on drilling fluids and drill cuttings and produced waters that would be discharged offshore are discussed in **Chapter 4.1.1.4.**, Operational Waste Discharged Offshore. Effluents are routinely discharged into offshore waters and are regulated by USEPA NPDES permits. Cetaceans may periodically be exposed to these discharges. Direct effects to cetaceans are expected to be sublethal. Indirect effects via food sources are not expected due to dilution and dispersion of offshore operational discharges. It should be noted, however, that any pollution in the effluent could potentially poison, kill, debilitate, or stress marine mammals and adversely affect prey species and other key elements of the GOM ecosystem (Tucker & Associates, Inc., 1990). Operational discharges could periodically contact and/or affect marine mammals.

It is assumed that helicopter traffic would occur on a regular basis. It is projected that 475-1,075 OCS-related helicopter trips would occur annually in the support of OCS activities in the EPA (**Table 4-4**) and 378,718-883,333 trips in the CPA (**Table 4-5**). The FAA (Advisory Circular 91-36C) and corporate helicopter policy state that helicopters must maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between offshore structures. In addition, guidelines and regulations promulgated by NOAA Fisheries under the authority of the Marine Mammal Protection Act include provisions specifying helicopter pilots to maintain an altitude of 1,000 ft within 300 ft (91 m) of marine mammals. It is unlikely that cetaceans would be affected by routine OCS helicopter traffic at these altitudes, provided pilots do not alter their flight patterns to more closely observe or photograph marine mammals that they see. It is also expected that 10 percent of helicopter trips would occur at altitudes below the specified minimums listed above as a result of inclement weather. Routine overflights may elicit a startle response from and disturb nearby cetaceans (depending on the activity of the animals) (Richardson et al., 1995). Occasional overflights probably have no long-term consequences on cetaceans; however, frequent overflights could have long-term consequences if they occur repeatedly and disrupt vital activities, such as feeding and breeding. The OCS-related helicopters are not the only aircraft that fly over the coastal and offshore areas. Military, private, and commercial aircraft also traverse these areas and may impact marine mammals.

It is projected that 525-1,050 OCS-related, service-vessel trips would occur annually in support of OCS activities in the EPA (**Table 4-4**) and 272,923-281,948 trips (**Table 4-5**) in the CPA 475-1,075. Noise from service-vessel traffic may elicit a startle and/or avoidance reaction by cetaceans and mask their sound reception. It is expected that the extent of service-vessel traffic predicted in the cumulative scenario could affect cetaceans either by active avoidance or displacement of individuals or groups to less suitable habitat areas. Reaction would most likely vary with species, age, sex, and psychological status; the most vulnerable might be perinatal females and nursing calves, and those animals stressed by parasitism and disease. The presence of multiple noise sources is expected to increase masking, disrupt routine behavioral activities, and cause short-term displacement (Richardson et al., 1995). Although the proportion of a marine mammal population exposed to noise from any one source may be small, the proportion exposed to at least one noise source may be much greater (Richardson et al., 1995). The net result of any disturbance would be dependent upon the size and percentage of the population likely to be affected; ecological importance of the disturbed area; environmental and biological parameters that influence an animal's sensitivity to disturbance and stress; or the accommodation time in response to a prolonged disturbance (Geraci and St. Aubin, 1980).

It is expected that the extent of service-vessel traffic in the cumulative scenario would affect cetaceans either via avoidance behavior or displacement of individuals or groups. Smaller delphinids may approach vessels that are in transit to bow-ride. There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or productivity, unless they occur frequently. Long-term displacement of animals from an area is also a possibility. It is not known whether toothed whales exposed to recurring vessel disturbance would be stressed or otherwise affected in a negative but inconspicuous way. Increased vessel traffic would increase the probability of collisions between vessels and marine mammals, resulting in injury or death to some animals (Laist et al., 2001).

In addition to OCS-related vessel trips, there are numerous other vessels traversing coastal and offshore waters that could impact marine mammals. **Chapter 4.1.3.2.3.**, Marine Transportation, discusses non-OCS-related oil tanker and non-OCS-related vessel and freight traffic. A large number of commercial and recreational fishing vessels use these areas.

It is projected that 46-81 exploration and delineation wells and 85-163 development wells would be drilled in support of OCS activities in the EPA (**Table 4-4**), and 7,108-8,584 exploration and delineation wells and 12,553-15,052 development wells in the CPA (**Table 4-5**).

Drilling activities produce sounds at intensities and frequencies that could be heard by cetaceans. It is estimated that noise from drilling activities would be relatively constant, lasting no longer than four months at each location. Sound levels generated by drilling operations are generally low frequency (Gales, 1982). Odontocetes echolocate and communicate at higher frequencies than the dominant sounds generated by drilling platforms. The bottlenose dolphin is sensitive to high-frequency sounds and is able to hear low-frequency sounds; however, where most industrial noise energy is concentrated, sensitivity appears to be poor (Richardson et al., 1995). Baleen whales appear to be sensitive to low- and moderate-frequency sounds, but as mentioned by Richardson et al. (1995), the lack of specific data on hearing abilities of baleen whales is of special concern since baleen whales apparently are more dependent on low-frequency sounds than are other marine mammals. The effects on cetaceans from structure noise are expected to be sublethal and may elicit some degree of avoidance behavior and temporary displacement; interference with ability to detect calls from conspecifics, echolocation pulses, or other important natural sounds; or might cause temporary reduction in hearing sensitivity. It is expected that drilling noise would periodically disturb and affect cetaceans in the GOM. Nonetheless, exploratory wells have been drilled in the Mississippi Canyon region since 1985. Marine mammal surveys performed for MMS show that this region is inhabited by sperm whales (chiefly cows and calves) (Weller et al., 2000). Tagging and photo-identification data gathered as recently as the summer of 2001 show that sperm whales continue to use the region, even though OCS activity has increased in this area since the 1980's. Since 1991, MMS has funded multiple studies and surveys of cetaceans in the northern GOM. The resulting information has greatly expanded our knowledge regarding the occurrence, ecology, and behavior of marine mammals in the area. The MMS will continue to work with the MMC, NOAA Fisheries, and others involved in the study and protection of marine mammals to enhance our understanding of whether or not OCS activities have caused behavioral modifications among marine mammals occupying the region.

Potential impacts to marine mammals from the detonation of explosives include mortality, injury, and physical or acoustic harassment. Injury to the lungs and intestines and/or auditory system could occur. Harassment of marine mammals as a result of the explosion-generated shock wave and acoustic signature of the detonation is also possible. Resuspension of bottom sediments, increased water turbidity, and mobilization of bottom sediments due to detonating explosives are considered to be temporary effects. An estimated 10-12 and 3,676-4,183 structure removals are projected to occur in the EPA (**Table 4-4**) and CPA (**Table 4-5**), respectively, between 2003 and 2042. It is expected that structure removals would cause only minor, physiological response effects on cetaceans, basically because of MMS and NOAA Fisheries guidelines for explosive removals.

Seismic surveys generate a more intense noise than other nonexplosive survey methods. Baleen whales seem tolerant of low- and moderate-level noise pulses from distant seismic surveys but exhibit behavioral changes to nearby seismic activity (Richardson et al., 1995). Subtle effects on surfacing, respiration, and dive cycles have been noted (shorter surfacings, shorter dives, and fewer blows per surfacing) (Richardson et al., 1995; Richardson, 1997). Bowhead and gray whales often show strong avoidance within 6-8 km of an airgun array. Strong avoidance of seismic pulses has been reported for bowheads as far as 24 km from an approaching seismic boat (Richardson, 1997). Bowheads have also been seen within 18.5-37.0 km of ongoing seismic operations, well inside the ensonified area (Richardson, 1997). Whales exposed to noise from distant seismic ships may not be totally unaffected even if they remain in the area and continue their normal activities (Richardson et al., 1995). There seems to be a graduation in response with increasing distance and decreasing sound level, and conspicuousness of effects diminishes, meaning that reactions may not be easy to see at a glance (Richardson, 1997). One report of sperm whales in the GOM indicated that the whales ceased vocalizations when seismic activity in the area was occurring (Davis et al., 1995) and that sperm whales may have moved 50+ km away (Mate et al., 1994). Goold (1996) found that acoustic contacts with common dolphins dropped sharply as soon as seismic activity began. Sperm whales during the Heard Island Feasibility Test were found to cease calling during some times when seismic pulses were received from an airgun array >300 km away (Bowles et al., 1994). Swift et al. (1999) found few, if any, effects of airgun noise on sperm whales in an area of the northeast Atlantic. No obvious behavior modifications relative to the seismic activity were recorded during the majority of the small odontocete observations made during marine mammal monitoring carried out by Impact Sciences during an Exxon 3D seismic survey offshore California in late 1995 (Arnold, 1996). There was also no observed obvious behavior modification or harassment of large whales attributable to the sound effects of the survey (Arnold, 1996). For baleen whales, in particular, it is not known (1) whether the same individuals return to areas of previous seismic exposure, (2) whether seismic work has caused local changes in distribution or migration routes, or (3) whether whales that tolerate strong seismic pulses are stressed (Richardson et al., 1995). There are no data on auditory damage in marine mammals relative to received levels of underwater noise pulses (Richardson et al., 1995). Indirect "evidence" suggests that extended or repeated exposure to seismic pulses is unlikely to cause permanent hearing damage in marine mammals, given a study of damage risk criteria; the transitory nature of seismic exploration; the presumed ability of marine mammals to tolerate exposure to strong calls from themselves or other nearby mammals; and the avoidance responses that occur in at least some baleen whales when exposed to certain levels of seismic pulses (Richardson et al., 1995). Although any one seismic survey is unlikely to have long-term effects on any cetacean species or population, available information is insufficient to be confident that seismic activities, collectively, would not have some effect on the size or productivity of any marine mammal species or population. These effects would likely be nonlethal.

Oil spills and oil-spill response activities can adversely affect cetaceans, causing skin and soft tissue 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. Previous studies suggested that contact with oil and consumption of oil and oil-contaminated prey are unlikely cause more than temporary, nonlethal effects on cetaceans (Geraci, 1990). However, evidence from the *Exxon Valdez* spill indicates that oil spills have the potential to cause greater chronic (sublethal oil-related injuries) and acute (spill-related deaths occurring during a spill) effects on mammals than originally suggested. Sea otters have had decreased survival rates in the years following the *Exxon Valdez* spill, and the effects of the spill on annual survival increased rather than dissipated for animals alive when the spill occurred (Monson et al., 2000). Some short-term (0-1 month) effects of oil may be (1) changes in cetacean distribution 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) sublethal initial 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). A few long-term effects include (1) change in distribution and abundance because of reduced prey resources or 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). Effects of cleanup activities are unknown, but increased human presence (e.g., vessels) could influence cetacean behavior and/or distribution, thereby stressing animals more, and subsequently increasing their vulnerability to various anthropogenic and natural sources of mortality. In the event that oiling of cetaceans should occur from spills, the effects would probably be sublethal; few proximate deaths are expected; however, long-term impacts might be more lethal to some animals.

Oil spill estimates project that there would be numerous, frequent, small spills; many, infrequent, moderately sized spills, and infrequent, large spills occurring in coastal and offshore waters between 2003 and 2042 (**Table 4-15**). The probability that a marine mammal is exposed to hydrocarbons resulting from a spill extends well after the oil spill has dispersed from its initial aggregated mass. Populations of marine mammals in the northern GOM would be exposed to residuals of oils spilled stemming from past, present, and future lease sales during their lifetimes.

A wide variety of debris is commonly observed in the GOM. Marine debris comes from a variety of terrestrial and marine sources (Cottingham, 1988), and all debris is anthropogenic in origin. Some material is accidentally lost during drilling and production operations. The offshore oil and gas industry was shown to contribute 13 percent of the debris found at Padre Island National Seashore (Miller et al., 1995). Both entanglement in and ingestion of debris has caused the death or serious injury of individual marine mammals. The probability of entanglement or ingestion is largely unpredictable, but it is believed to be low.

Stock structure is completely unknown for all species in the GOM, except for the bottlenose dolphin (Waring et al., 1997). Life history parameters have not been estimated for cetacean stocks in the GOM, except for some coastal bottlenose dolphin stocks (Odell, 1975; Urian et al., 1996). Stock definition for bottlenose dolphins is problematic; there are a variety of possible stock structures (Blaylock and Hoggard, 1994). Inshore and offshore forms of bottlenose dolphins are commonly recognized based on morphological and ecological evidence (Hersh and Duffield, 1990). Recent work has confirmed significant genetic differences between inshore and offshore bottlenose dolphins in the GOM (Curry et al., 1995; LeDuc and Curry, 1997). There has been speculation that the population of bottlenose dolphins along the southeastern coast of the United States is structured such that there are local, resident stocks in certain embayments and transient stocks that migrate into and out of these embayments seasonally (Scott, 1990). There is reason to believe that some genetic exchange may occur between bottlenose dolphins inhabiting coastal waters and dolphins from bays and sounds in the GOM (Blaylock and Hoggard, 1994). Differences in bottlenose dolphin reproductive seasonality from site to site also suggest genetic-based distinctions between communities (Urian et al., 1996).

Since the inception of the Marine Mammal Protection Act (1972), over 500 bottlenose dolphins have been live-captured and removed from southeastern U.S. waters for public display and scientific research purposes (USDOC, NMFS, 1989b). The live-capture fishery is managed under the 2 percent quota rule and based on the best available information relating to the bottlenose dolphin population abundance, stock structure, and productivity in the region (Scott and Hansen, 1989). Almost half of these dolphins were caught in the Mississippi Sound area (Tucker & Associates, Inc., 1990). Captures in the past had concentrated on the female portion of the stock, which in turn could significantly lower the potential for future recruitment (Scott, 1990). Capture activities may also stress and affect the survival and productivity of animals that are chased and captured, but not removed (Young et al., 1995; Myrick, 1988). Anomalous mortality events resulted in a temporary, if not permanent, cessation of the live-capture fishery for bottlenose dolphins in the southeastern United States (USDOC, NOAA, 1996).

Several anomalous mortality events (die-offs) have been reported for cetaceans. In the GOM, bottlenose dolphins have been involved in several unusual mortality events since 1990. The death of 26 bottlenose dolphins in Matagorda Bay in January 1990 was attributed to cold weather (Miller, 1992). No conclusive evidence for a single or multiple causal agent(s) was provided for the other 300+ animals that were part of the 1990 die-off on the Gulf Coast (Hansen, 1992). A localized die-off of dolphins in East Matagorda Bay in 1992 was suggested to be due to agricultural run-off (trace amounts of Aldecarb were found in the water) (Worthy, personal communication, 1995). Bottlenose dolphin stocks in the northern and western coastal portion of the northern Gulf Coast may have experienced a morbillivirus epidemic in 1993 (Lipscomb et al., 1996). In 1994, 67 percent of tested samples of a die-off of bottlenose dolphins in East Texas/Louisiana revealed that morbillivirus was present (Worthy, personal communication, 1995). A period of increased stranding of bottlenose dolphins from October 1993 through April 1994 in Alabama, Mississippi, and Texas was determined to have been caused by a morbilliviral epizootic (Lipscomb et al., 1996; Taubenberger et al., 1996). A die-off of bottlenose dolphins occurred in 1995 on the west coast of Florida (Hansen, personal communication, 1997) and on the Mississippi coast in November 1996 (Rowles, personal communication, 1996). Propagation of the morbilliviral epizootic along the coast is probably determined by contact between adjacent communities and seasonal movements of transient dolphins (Duignan et al., 1995a and 1996).

Concentrations of mortality do not appear widespread, appearing to occur in localized populations. To understand the impact and long-term effects, large-scale surveys are needed to assess impacts on the offshore dolphin distribution, while localized, small-scale surveys are required to quantify pre- and post-effects of the disease (Scott and Hansen, 1989). Blaylock and Hoggard (1994) noted that bottlenose dolphins living in enclosed systems (bays) in the U.S. might be subject to increased anthropogenic mortality due to their proximity to humans. Such dolphins would also be at increased risk of being affected by catastrophic events or by chronic, cumulative exposure to anthropogenic activities or compounds.

In spring 1996, 150 manatees were involved in a die-off; brevotoxin (red tide) was determined to be the cause (Suzik, 1997). At a regional level, 20 percent of the population was involved, while at the State level, it was 6 percent (Wright, personal communication, 1996). Sixteen manatees died in November 1997 as a result of a red tide in the same region of southwestern Florida where the 1996 die-off occurred (MMC, 1998). The first well-documented, manatee mortality event associated with a red tide was in 1982 (O'Shea et al., 1991). Free-ranging manatee exposure to a morbillivirus has been reported (Duignan et al., 1995b). The authors suggested that the infection in Florida manatees is sporadic rather than enzootic (as in cetaceans); however, Florida manatees may be at risk nonetheless for disease transmission between cows and their calves, between estrus herds, and during aggregations in warm-water refuges (which is also the most stressful time of year energetically for these animals). Morbillivirus could then affect manatees either directly or through immunosuppression or abortion (Duignan et al., 1995b). Papillomavirus has recently been found in Florida manatees (Bossart, personal communication, 1997).

A variety of environmental contaminants have been found in GOM bottlenose dolphins (e.g., Haubold et al., 1993; Davis et al., 1993; Meador et al., 1995) and manatees (O'Shea et al., 1984; Ames and van Vleet, 1996). Atlantic spotted dolphins from the GOM have lower contaminant levels than GOM bottlenose dolphins (Hansen, personal communication, 1997). Some marine mammals are high-order predators that may be affected by the bioaccumulation of contaminants (Reijnders, 1986a). Manatees, as herbivores, are exposed to pesticides through ingestion of aquatic vegetation containing concentrations of these compounds. The reliance of manatees on inshore habitats and their attraction to industrial and municipal outfalls has the potential to expose them to relatively high levels of contaminants (USDOI, FWS, 2001c). Contaminants, siltation, and modified deliveries of freshwater to the estuary can indirectly impact manatees by causing a decline in submerged vegetation on which manatees depend (USDOI, FWS, 2001c). Manatees do not appear to accumulate large quantities of chlorinated pesticides (O'Shea et al., 1984; Ames and van Vleet, 1996). Manatees, as herbivores, occupy a lower position in the food chain than most other marine mammals. Most marine mammal species have large stores of fat, acting both as insulation and as an energy reserve. Lipophilic contaminants can accumulate in this tissue and may be released at high concentrations when the energy reserves are mobilized (UNEP, 1991).

Recently, significant accumulation of butyltin compounds (tributyltin is an antifouling agent to prevent attachment of barnacles on boat hulls) has been implicated for immune suppression and consequent disease outbreak (Kannan et al., 1997). High butyltin concentrations in liver and kidney were found in bottlenose dolphins stranded along the Atlantic and Gulf Coasts of Florida (Kannan et al., 1997). Butyltin concentrations in the livers of spotted dolphin and pygmy sperm whale were found to be 3-4 times lower than in bottlenose dolphins; it was suggested that since these are offshore species, the exposure to butyltins is expected to be minimal (Kannan et al., 1997). Butyltins tend to magnify less in cetaceans as compared to organochlorines, which exert chronic toxic effects in marine mammals. Laboratory studies demonstrate that butyltin compounds are potent inhibitors of energy production in cells, followed by lymphocyte depletion and decreased phagocytic activity resulting in immunotoxicity. Kannan et al. (1997) suggested that butyltin compounds in addition to PCB's have contributed to the immune suppression in bottlenose dolphins.

Insufficient information is available to determine how, or at what levels and in what combinations, environmental contaminants may affect marine mammals (MMC, 1999). There is growing evidence that high contaminant burdens are associated with several physiological abnormalities, including skeletal deformations, developmental effects, reproductive and immunological disorders, and hormonal alterations (e.g., Reijnders, 1986b; Addison, 1989; Brouwer et al., 1989; Colborn et al., 1993; De Swart et al., 1994; Reijnders, 1994; Lahvis et al., 1995; Smolen and Colborn, 1995). It is possible that anthropogenic chemical contaminants initially cause immunosuppression, rendering dolphins susceptible to opportunistic bacterial, viral, and parasitic infection (De Swart et al., 1995). Studies indicate an inverse relationship between hydrocarbon contaminant levels and certain bacterial and viral antigen titers in *Tursiops* from Matagorda Bay (in Waring et al., 1997). Contaminant loads were also associated with decreased levels of testosterone (Rowles, personal communication, 1996). Debilitating viruses such as morbillivirus may result in further immunosuppression and death. A study by Ross et al. (1996) indicated that present levels of PCB's in the aquatic food chain are immunotoxic to mammals. It should also be noted that emaciated animals that have mobilized their lipid stores (which accumulate high concentrations of toxic chemicals) may be more susceptible to toxic effects as a result of remobilization of the pollutants. Several Mediterranean striped dolphins that died during a morbillivirus epizootic and that had high levels of PCB's were found to have luteinized ovarian cysts (Munson et al., 1998). Such cysts may impede population recovery from the epidemic if similar cysts occurred on surviving dolphins (Munson et al., 1998).

Air pollution is also a health factor for cetaceans. Anthracosis has been identified in the lungs of a sample of stranded dolphins in the Sarasota Bay area, but the implications of this finding are not yet clear (Rawson et al., 1991). Participants in workshops convened by MMS in 1989 and 1999 recommended that levels of environmental contaminants and natural biotoxins should be determined and monitored in representative marine mammals that occur in the northern GOM (e.g., Tucker & Associates, Inc., 1990). Collectively, the National Marine Mammal Tissue Bank, the quality assurance and contaminant monitoring programs, and the regional marine mammal stranding networks constitute NOAA Fisheries' marine mammal health and stranding response program.

Commercial fisheries accidentally entangle and drown or injure marine mammals during fishing operations or by lost and discarded fishing gear; they may also compete with marine mammals for the same fishery resources (e.g., Northridge and Hofman, 1999). There is little information on cetacean/fishery interactions in GOM waters. Bottlenose dolphins have become entangled in recreational and commercial fishing gear. Bottlenose dolphins are often seen feeding in association with shrimp fishery operations (e.g., Fertl, 1994; Fertl and Leatherwood, 1997). Dolphins in coastal and neritic waters have been killed in shrimp trawls, as well as in experimental trawling for butterfish (Burn and Scott, 1988). Although the catch rate may be low, fisheries such as the shrimp trawl fishery with large fleets may be having significant impacts on dolphins. Marine mammals may be caught and killed occasionally in the menhaden purse seine fishery (Tucker & Associates, Inc., 1990). Dolphins have been stranded on the Gulf Coast with evidence of gillnet entanglement (e.g., Burn and Scott, 1988). There are several pelagic fisheries that may potentially take dolphins during their operations. From 1957 to 1982, the Japanese fished for tuna with longlines in the GOM (Russell, 1993, in Jefferson, 1995). There is no information on incidental catch of cetaceans in this fishery, but cetaceans have been taken on longlines off the U.S. east coast (Burn and Scott, 1988). The most likely major pelagic fishery in the GOM to incidentally take dolphins is the domestic tuna/swordfish longline fishery started in the offshore GOM in the early 1970's, and it continues today (Russell, 1993, in Jefferson, 1995). There is no marine mammal observer program for this fishery, although there are anecdotal reports of pilot whales and possibly Risso's dolphins taking fish off the longlines.

The level of take in GOM fisheries may be small (e.g., Reynolds, 1985; Burn and Scott, 1988), but as iterated by Tucker & Associates, Inc. (1990), the effects could be causing, or contributing to, significant population declines if the affected populations also are subject to other human-produced impacts. Information continues to be insufficient to assess the nature and extent of incidental take, its impact on affected species and populations, or how it might be reduced or avoided. In addition, shooting of bottlenose dolphins occurs infrequently. A minke whale that stranded in the Florida Keys was found to have several bullets in it (USDOC, NOAA, 1997b). These few cases may be simple vandalism or may be fisheries-related (Burn and Scott, 1988) (in response to real or perceived damage to gear and/or catch). Although the extent of incidental take and death during "ghost" fishing is largely undocumented, it has been noted as an activity of concern by NOAA Fisheries and MMC. Fishermen have been reported to shoot at dolphins to scare them away from their gear (e.g., Reynolds, 1985; Fertl, 1994; Fertl and Leatherwood, 1997). It is expected that commercial fishing equipment would periodically contact and affect cetaceans in the GOM.

Adequate conservation strategies for marine mammals must take into account the natural history and ecology of important prey species; this is something that is currently under emphasized in research and conservation efforts (Heithaus and Connor, 1995; Trites et al., 1997). For example, Trites et al. (1997)

suggested that fisheries may indirectly compete with marine mammals by reducing the amount of primary production accessible to marine mammals, thereby negatively affecting marine mammal numbers.

Habitat loss and degradation is now acknowledged to be a significant threat to cetacean populations. The impact of coastal development on GOM cetaceans has not been adequately investigated. It has been suggested that apparent declines in bottlenose dolphin abundance in some areas can be attributed to pollution and heavy boat traffic (e.g., Odell, 1976). Bottlenose dolphins in Sarasota Bay appear to use less-altered areas more frequently, but specific effects are uncertain (Wells, 1992). On the other hand, habitat alteration in the form of artificial passes in southern Texas may have opened up new habitat for bottlenose dolphins (Leatherwood and Reeves, 1983). Habitat alteration has the potential to disrupt the social behavior, food supply, and health of cetaceans that occur in the GOM. Such activities may stress animals and cause them to avoid traditional feeding and breeding areas, or migratory routes. The most serious threat to cetacean populations from habitat destruction may ultimately prove to be its impact on the lower trophic levels of their food chains (Kemp, 1996). Intensive coastal development is degrading important manatee habitat and poses perhaps the greatest long-term threat to the Florida manatee (USDOI, FWS, 2001c).

Coastal bottlenose dolphin populations in the southeastern U.S. have the potential to be impacted by commercial dolphin-watching trips that feed dolphins as part of their tours. Feeding wild dolphins is likely to disrupt normal behavior, particularly feeding and migration patterns (USDOC, NMFS, 1994b). This activity could make dolphins dependent upon unnatural food sources and more vulnerable to being hit by boats, malicious shooting, and accidental or deliberate food poisoning (USDOC, NMFS, 1994b). Although the Marine Mammal Protection Act classifies such activities as "harassment," feeding continues due to lack of enforcement. In May 1997, NMFS embarked upon a media and education campaign in Florida (including Panama City Beach, which is an area of particular concern) to increase public awareness about the dangers of swimming with, feeding, and harassing wild dolphins (Seideman, 1997). In July 1999, a Federal Court upheld a $4,500 fine against a group of people in the Florida panhandle for harassing or attempting to harass dolphins by feeding or attempting to feed them (USDOC, NOAA, 1999). Spradlin et al. (1999) provides additional guidance concerning interactions between the public and wild dolphins. Migrating baleen whales may be affected by whale-watching activities on the East Coast, as well as in the Caribbean (Hoyt, 1995). Impacts of whale watching on cetaceans may be measured in a short time-scale (i.e., startle reaction) or as a long-term effect on reproduction or survivability (IFAW, 1995). There is little evidence to show that short-term impacts have any relation to possible long-term impacts on cetacean individuals, groups, or populations (IFAW, 1995). There are six manatee sanctuaries in Kings Bay; human access to these areas is prohibited to provide manatees a place to avoid disturbance by divers and boats. A number of cases of harassment of manatees by divers have involved waters around Three Sisters Spring, located in a canal off Kings Bay (Seideman, 1997; MMC, 1998). Manatees were forced away from the spring by divers approaching to touch them or to pose for photographs with them (MMC, 1998). The NOAA Fisheries has published viewing guidelines on their webstie (http://www.nmfs.noaa.gov/prot_res/mmwatch/southeast.htm).

It is possible that harassment in any form may cause a stress response (Young et al., 1995). Marine mammals can exhibit some of the same stress symptoms as found in terrestrial mammals (Thomson and Geraci, 1986). Stress often is associated with release of adrenocroticotrophic hormones or cortisol. Thomas et al. (1990) examined the effect of playbacks of drilling platform noise on captive belugas. They found no behavioral (swim patterns, social group interactions, and dive/respiration rates) or physiological (blood catecholamines) indications of stress from drilling noises. It is important to recognize that disturbance from vessel traffic, noise from ships, aircraft, and drilling rigs and/or exposure to sublethal levels of biotoxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them more vulnerable to parasites and diseases that normally would not be fatal. Chronic stress may cause damage to the heart muscle and vasculature (Curry and Edwards, 1998). Stressed animals may also fail to reproduce at normal rates or exhibit significantly high fetotoxicity and malformations in the young, as evidenced in some small laboratory mammals. For example, a heavily fished population of spotted dolphins in the eastern tropical Pacific was found to have a substantially lower pregnancy rate and a significantly higher (i.e., delayed) age at sexual maturity than nearby, sporadically fished, spotted dolphins; chronic stress is one possibility (Myrick and Perkins, 1995). Marine mammals may stay in an area despite disturbance (such as noise) if no alternative, suitable habitat areas are available to the animals.

The incremental contribution of impacts stemming from a proposed action is expected to be primarily sublethal (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris). However, cumulative impacts of the activities discussed in this section would likely yield deleterious effects to cetaceans occurring in the GOM. Biological significance of any mortality would depend, in part, on the size and reproductive rates of the affected stocks, as well as the number, age, and sex of animals affected.

Summary and Conclusion

Activities considered under the cumulative scenario could affect protected cetaceans and sirenians. These marine mammals could be impacted by the degradation of water quality resulting from operational discharges, OCS and non-OCS vessel traffic, noise generated by platforms, drillships, helicopters and vessels, seismic surveys, explosive structure removals, oil spills, oil-spill response activities, loss of debris from service vessels and OCS structures, commercial fishing, capture and removal, and pathogens. The cumulative impact on marine mammals is expected to result in a number of chronic and sporadic sublethal effects (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris) that may stress and/or weaken individuals of a local group or population and predispose them to infection from natural or anthropogenic sources. Few deaths are expected from oil spills, chance collisions with OCS service vessels, ingestion of plastic material, commercial fishing, and pathogens. Oil spills of any size are estimated to be recurring events that would periodically contact marine mammals. Deaths as a result of structure removals are not expected to occur due to mitigation measures (e.g., NOAA Fisheries Observer Program). Disturbance (noise from vessel traffic and drilling operations, etc.) and/or exposure to sublethal levels of toxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them more vulnerable to parasites and diseases that normally would not be fatal. The net result of any disturbance would be dependent upon the size and percentage of the population likely to be affected; ecological importance of the disturbed area; environmental and biological parameters that influence an animal's sensitivity to disturbance and stress; or the accommodation time in response to prolonged disturbance (Geraci and St. Aubin, 1980). Collisions between cetaceans and ships, though expected to be rare events, could cause serious injury or mortality.

Effects of the incremental contribution of a proposed action combined with non-OCS activities may be deleterious to cetaceans occurring in the GOM. Biological significance of any mortality would depend, in part, on the size and reproductive rates of the affected stocks, as well as the number, age, and size of animals affected.

4.5.6. Impacts on Sea Turtles

This cumulative analysis considers the effects of impact-producing factors related to a proposed action plus those related to other OCS activities; State oil and gas activity; crude oil imports by tanker; and other commercial, military, recreational, offshore and coastal activities that may have occurred or may occur and adversely affect populations of sea turtles in the same general area of a proposed action. The combination of potential impacts resulting from a proposed action in addition to prior and future OCS lease sales, State oil and gas activity, dredge-and-fill operations, water quality degradation, natural catastrophes, pollution, recreational and commercial fishing, dredges, vessel traffic, beach nourishment, beach lighting, power plant entrainment, and human consumption affect the loggerhead, Kemp's ridley, hawksbill, green, and leatherback turtles found in the GOM. The impacts related to a proposed action are reviewed in detail in **Chapters 4.2.1.6.** and **4.4.6.** Sections providing supportive material for the sea turtle analysis include **Chapters 3.1.** (Physical Environment), **3.2.4.** (Sea Turtles), **4.1.1.** (Offshore Impact-Producing Factors and Scenario), **4.1.2.** (Coastal Impact-Producing Factors and Scenario), **4.1.3.** (Other Cumulative Activities Scenario) and **4.4.6.** (Impacts on Sea Turtles).

Effluents are routinely discharged into offshore waters and are regulated by USEPA NPDES permits. Most operational discharges are diluted and dispersed when released in offshore areas and, given the current USEPA permit restrictions on discharges, are considered to have little effect (API, 1989; Kennicutt, 1995). Any potential that might exist for impact from drilling fluids would seem to be indirect, either by impact on prey items or possibly through ingestion via the food chain (API, 1989). Contaminants in drilling mud discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of sea turtles or species lower in the marine food web (for further information on bioaccumulation, see **Chapter 4.1.1.4.1.**, Drilling Muds and Cuttings). This may ultimately reduce reproductive fitness in turtles, an impact that the diminished population(s) cannot tolerate.

Structure installation and removal, pipeline placement, dredging, and water quality degradation may adversely affect sea turtle foraging habitat through destruction of seagrass beds and live-bottom communities used by sea turtles (Gibson and Smith, 1999). At the same time, it should be noted that structure installation creates habitat for subadult and adult sea turtles, which may enhance the recovery of some turtle populations. Potential impacts on these habitats caused by the OCS Program in the cumulative activity area are discussed in detail in **Chapters 4.5.3.3. and 4.5.4.1.1.**

Noise from service-vessel and helicopter traffic may cause a startle reaction from sea turtles and produce temporary stress (NRC, 1990). It is projected that 475-1,075 OCS-related helicopter trips would occur annually in the support of OCS activities in the EPA (**Table 4-4**) and 378,718-883,333 trips in the CPA (**Table 4-5**). The FAA's Advisory Circular 91-36C encourages pilots to maintain greater than minimum altitudes near noise-sensitive areas. Corporate helicopter policy states that helicopters should maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms. The OCS-related helicopters are not the only aircraft that fly over the coastal and offshore areas. Military, private, and commercial air traffic also traverse these areas and have the potential to cause impacts to sea turtles. Other sound sources potentially impacting sea turtles include seismic surveys. Seismic surveys use airguns to generate sound pulses; these are a more intense sound than other nonexplosive sound sources. Data are limited but show that reactions of turtles to seismic pulses deserve detailed study. Seismic activities would be considered primarily annoyance and probably cause a short-term behavioral response.

The potential impacts of anthropogenic sounds on sea turtles include physical auditory effects (temporary threshold shift), behavioral disruption, long-term effects, masking, and adverse impacts on the food chain. Noise-induced stress has not been studied in sea turtles. It is expected that drilling noise would periodically disturb and affect turtles in the GOM. Based on the conclusions of Lenhardt et al. (1983) and O'Hara and Wilcox (1990), low-frequency sound transmissions (such as those produced by operating platforms) could cause increased surfacing and deterrence behavior from the area near the sound source.

Increased surfacing places turtles at greater risk of vessel collision. Collisions between service vessels or barges and sea turtles would likely cause fatal injuries. It is projected that 525-1,050 OCS-related, service-vessel trips would occur annually in support of OCS activities in the EPA (**Table 4-4**), and 272,923-281,948 trips (**Table 4-5**) in the CPA. Vessel traffic in general is estimated to cause about 9 percent of all sea turtle deaths in the southeastern U.S., and this mortality would likely increase if recreational fishing and OCS Program vessel traffic continue to increase in the GOM. Regions of greatest concern may be those with high concentrations of recreational boat traffic, such as the many coastal bays in the GOM. **Chapter 3.3.5.6.**, Non-OCS-Related Marine Traffic, discusses non-OCS-related oil tanker and barge activities and non-OCS-related vessel and freight traffic. Numerous commercial and recreational fishing vessels also use these areas.

Explosive discharges such as those used for structure removals can cause capillary injury to sea turtles (Duronslet et al., 1986). Although sea turtles far from the site may suffer only disorientation, those near detonation sites would likely sustain fatal injuries. Injury to the lungs and intestines and/or auditory system could occur. Other potential impacts include physical or acoustic harassment. To minimize the likelihood of removals occurring when sea turtles may be nearby, MMS has issued guidelines for explosive platform removal to offshore operators. These guidelines include daylight-limited detonation, staggered charges, placement of charges 5 m below the seafloor, and pre- and post-detonation surveys of surrounding waters. Resuspension of bottom sediments, increased water turbidity, and mobilization of bottom sediments due to explosive detonation are considered to be temporary effects. An estimated 10-12 and 3,676-4,183 structure removals are projected to occur in the EPA (**Table 4-4**) and CPA (**Table 4-5**) respectively, between 2003 and 2042. With existing protective measures (NOAA Fisheries Observer Program and daylight-only demolition) in place, it is expected that "take" of sea turtles during structure removals would be limited. No explosive removals are projected to occur in the EPA.

Sea turtles may be seriously affected by marine debris. Trash and flotsam generated by the OCS Program in the GOM and other users of the GOM (Miller and Echols, 1996) is transported around the GOM and Atlantic via oceanic currents (Plotkin and Amos, 1988; Hutchinson and Simmonds, 1992).

Turtles that consume or become entangled in trash or flotsam may become debilitated or die (Heneman and the Center for Environmental Education, 1988). Monofilament line is the most common debris to entangle turtles (NRC, 1990). Fishing-related debris is involved in about 68 percent of all cases of sea turtle entanglement (O'Hara and Iudicello, 1987). Floating plastics and other debris, such as petroleum residues drifting on the sea surface, accumulate in sargassum drift lines commonly inhabited by hatchling sea turtles; these materials could be toxic. In a review of worldwide sea turtle debris ingestion and entanglement, Balazs (1985) found that tar was the most common item ingested. High rates of oiling of hatchlings netted from sargassum rafts suggest that bioaccumulation may occur over their naturally long lifespan. Sea turtles, particularly leatherbacks, are attracted to floating plastic because it resembles food, such as jellyfishes. Ingestion of plastics sometimes interferes with food passage, respiration, and buoyancy and could reduce the fitness of a turtle or kill it (Carr, 1987; USDOC, NOAA, 1988; Heneman and the Center for Environmental Education, 1988; Lutz and Alfaro-Shulman, 1992). The MMS prohibits the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), prohibits the disposal of plastics at sea or in coastal waters.

Since sea turtle habitat in the GOM includes both inshore and offshore areas, sea turtles are likely to encounter spills. Oil spill estimates project that there would be numerous, frequent, small spills; many, infrequent, moderately sized spills, and infrequent, large spills occurring in coastal and offshore waters between 2003 and 2042 (**Table 4-15**). The probability that a sea turtle is exposed to hydrocarbons resulting from a spill extends well after the oil spill has dispersed from its initial aggregated mass. Populations of sea turtles in the northern GOM would be exposed to residuals of oils spilled stemming from past, present, and future lease sales during their lifetimes. Oil spills can adversely affect sea turtles by toxic ingestion or blockage of the digestive tract, inflammatory dermatitis, ventilatory disturbance, disruption or failure of salt gland function, red blood cell disturbances, immune responses, and displacement from important habitat areas (Witham, 1978; Vargo et al., 1986; Lutz and Lutcavage, 1989; Lutcavage et al., 1995). Sea turtles may become entrapped by tar and oil slicks and rendered immobile (Witham, 1978; Plotkin and Amos, 1988). In the past, tanker washings were the main source of this oil (Van Vleet and Pauly, 1987). Although disturbances may be temporary, turtles chronically ingesting oil may experience organ degeneration accumulate in tissues. Exposure to oil may be fatal, particularly to juvenile and hatchling sea turtles. Hatchling and juvenile turtles are particularly vulnerable to contacting or ingesting oil because currents that concentrate oil spills also form the habitat mats in which these turtles are sometimes found (Carr, 1980; Collard and Ogren, 1990; Witherington, 1994). There is also evidence that sea turtles feed in surface convergence lines, which could also prolong their contact with viscous weathered oil (Witham, 1978; Hall et al., 1983). Fritts and McGehee (1982) noted that sea turtle eggs were damaged by contact with weathered oil released from the Ixtoc spill. Epidermal damage in turtles is 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). Captive turtles exposed to oil either reduced the amount of time spent at the surface, possibly avoiding oil, or became agitated and demonstrated short submergence levels (Lutcavage et al., 1995). Sea turtles sometimes pursue and swallow tarballs, and there is no conclusive evidence that wild turtles can detect and avoid oil (Odell and MacMurray, 1986; Vargo et al., 1986). A loggerhead turtle sighted during an aerial survey in the GOM surfaced repeatedly within a surface oil slick for over an hour (Lohoefener et al., 1989). Oil might have a more indirect effect on the behavior of sea turtles. Assuming olfaction is necessary to sea turtle migration, oil-fouling of a nesting area may disturb imprinting of hatchling turtles or confuse turtles during their return migration after a 6- to 8-year absence (Geraci and St. Aubin, 1985). The effect on reproductive success could therefore be significant.

When an oil spill occurs, the severity of effects and the extent of damage to sea turtles are affected by geographic location, oil type, oil dosage, impact area, oceanographic conditions, and meteorological conditions (NRC, 1985). Eggs, hatchlings, and small juveniles are particularly vulnerable upon contact (Fritts and McGehee, 1982; Lutz and Lutcavage, 1989). Potential toxic impacts to embryos would depend on the type of oil and degree of weathering, type of beach substrate, and especially upon the developmental stage of the embryo. Although many observed 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).

Oil-spill response activities, such as vehicular and vessel traffic in coastal areas of seagrass beds and live-bottom communities, can alter sea turtle habitat and displace sea turtles from these areas. Effects on seagrass and reef communities have been noted (reviewed by Coston-Clements and Hoss, 1983). Impacting factors include artificial lighting from night operations, booms, machine and human activity, equipment on beaches and in intertidal areas, sand removal and cleaning, and changed beach landscape and composition. Some resulting impacts from cleanup could include interrupted or deferred nesting, crushed nests, entanglement in booms, and increased mortality of hatchlings due to predation during the extended time required to reach the water (Newell, 1995; Lutcavage et al., 1997; Witherington, 1999). The strategy for cleanup operations should vary, depending on season, recognizing that disturbance to nests may be more detrimental than oil (Fritts and McGehee, 1982). As mandated by the Oil Pollution Act of 1990 (**Chapter 1.3.**, Regulatory Framework), these areas are expected to receive individual consideration during oil-spill cleanup. Required oil-spill contingency plans include special notices to minimize adverse effects from vehicular traffic during cleanup activities and to maximize protection efforts to prevent contact of these areas with spilled oil. Studies are lacking of the effects of dispersants and coagulants on sea turtles (Tucker & Associates, Inc., 1990).

Information on nesting areas for turtles in the GOM may be found in **Chapter 3.2.4.**, Sea Turtles.

Sea turtles may be harmed by a variety of human activities throughout their ranges, particularly because of their wide-ranging movements in coastal waters. Major activities affecting sea turtles inhabiting the GOM include commercial fishing, hopper dredging, pollutant discharge, ingestion of or entanglement in debris, coastal boat traffic, human consumption, and contact with foreign, inshore, or processed oil (reviewed in NRC, 1990; Lutcavage et al., 1997). Demographic analyses suggest reducing human-induced mortality of juvenile, subadult, or adult life stages would significantly enhance population growth, more so than reducing human-induced mortality of eggs and hatchlings (NRC, 1990).

The chief areas utilized by Kemp's ridleys (coastal waters less than 18 m in depth) overlap with that of the shrimp fishery (Renaud, 1995). A major source of mortality for loggerhead and Kemp's ridleys is capture and drowning in shrimp trawls (Murphy and Hopkins-Murphy, 1989); 70-80 percent of turtle strandings are related to interactions with this fishery (Crowder et al., 1995). Recent analysis of loggerhead strandings in South Carolina indicates a high turtle mortality rate from the shrimp fishery through an increase in strandings, and that the use of turtle excluder devices (TED) could greatly reduce strandings (a 44% reduction) (Crowder et al., 1995). On the other hand, Caillouet et al. (1996) found a significant positive correlation between turtle stranding rates and shrimp fishing intensity in the northwestern GOM. The Kemp's ridley population, due to its distribution and small numbers, is at greatest risk. In response to increased numbers of dead sea turtles that washed up along the coasts of Texas, Louisiana, Georgia, and northeast Florida in 1994-1995, and coincident with coastal shrimp trawling activity, NOAA Fisheries increased enforcement efforts (relative to TED's), which decreased the number of strandings. However, deaths are believed to occur in association with some inshore shrimping operations that do not presently require TED use (Crouse, 1992). Other fisheries and fishery-related activities are important sources of mortality, but are collectively only one-tenth as important as shrimp trawling (NRC, 1990). Turtles may be accidentally caught and killed in finfish trawls, seines, gill nets, weirs, traps, longlines, and driftnets, but deaths are neither fully documented nor regulated (Hillestad et al., 1982; NRC, 1990; Witzell, 1992; Brady and Boreman, 1994). Cannon et al. (1994) reported a number of Kemp's ridleys being caught by hook and line (Cannon et al., 1994). It is possible that some Kemp's ridleys surviving capture by hook and line may suffer from ill effects of hooks lodged in the esophagus or stomach following their release. Collisions with boats may also disable or kill sea turtles. In most cases, it is not possible to determine whether the injuries resulted in death or were post-mortem. An animal with an open wound has an increased probability of predation. Of the turtles stranded in the GOM, approximately 9 percent exhibited injuries attributed to boats (Teas and Martinez, 1992). Regions of increased concern are those with high concentrations of recreational-boat traffic, such as the coastal bays of the GOM.

Dredge-and-fill activities occur in many of the coastal areas inhabited by sea turtles. Operations range in scope from propeller dredging by recreational boats to large-scale navigation dredging and fill for land reclamation. Dredging operations affect turtles through accidental take and habitat degradation. Hopper dredging has caused turtle mortality in coastal areas, including Cape Canaveral Ship Channel in Florida and the King's Bay Submarine Channel in Georgia (Slay and Richardson, 1988); deaths in the GOM have not been estimated. Nearly all sea turtles entrained by hopper dredges are dead or dying when found, but an occasional small green turtle has been known to survive (NRC, 1990). In addition to direct take, channelization of the inshore and nearshore areas can degrade foraging and migratory habitats via spoil dumping, degraded water quality/clarity, and altered current flow.

Sea turtles frequent coastal areas such as algae and seagrass beds to seek food and shelter (Carr and Caldwell, 1956; Hendrickson, 1980). Coastal areas are also used by juvenile Kemp's ridleys in Louisiana (Ogren, 1989) and Texas (Manzella and Williams, 1992). Juvenile hawksbill, loggerhead, and green turtles are typically found in coastal Texas waters (Shaver, 1991). Submerged vegetated areas may be lost or damaged by activities altering salinity, turbidity, or natural tidal and sediment exchange. Natural catastrophes, including storms, floods, droughts, and hurricanes, can also substantially damage nesting beaches and coastal areas used by sea turtles (Agardy, 1990). Abnormally high tides and waves generated by storms may exact heavy mortality on sea turtles by washing them from the beach, inundating them with seawater, or altering the depth of sand covering them. Furthermore, excessive rainfall associated with tropical storms may reduce the viability of eggs. Turtles could be harmed in rough seas by floating debris (Milton et al., 1994). In addition, the hurricane season for the Caribbean and Western Atlantic (June 1-November 1) overlaps the sea turtle nesting season (March through November) (NRC, 1990). Nests are vulnerable to hurricanes during the incubation period as well as when hatchlings evacuate the nest. Hurricanes cause mortality at turtle nests in two ways: immediate drowning from ocean surges, and after hatching as a result of radically altered beach topography. The greatest surge effect from Hurricane Andrew was experienced at beaches closest to the "eye" of the hurricane; egg mortality was 100 percent (Milton et al., 1994). In areas farther from the "eye," the surge was lower and mortality was correspondingly decreased. Sixty-nine percent of eggs on Fisher Island in Miami, Florida did not hatch after Hurricane Andrew and appeared to have "drowned" during the storm (Milton et al., 1994). Further mortality occurred when surviving turtles suffocated in nests situated in the beach zone where sand had accreted. This subsequent mortality may be reduced if beach topography is returned to normal and beach debris removed after a hurricane (Milton et al., 1994). Species that have limited nesting ranges, such as the Kemp's ridley, would be greatly impacted if a hurricane made landfall at its nesting beach (Milton et al., 1994). Hurricane Erin caused a 40.2 percent loss in hatchling production on the southern half of Hutchinson Island in 1995 (Martin, 1996). A beach can be completely closed to nesting after a hurricane. For example, at Buck Island Reef National Monument on St. Croix, after Hurricane Hugo, 90 percent of the shoreline trees on the North Shore were blown down parallel to the water, blocking access to nesting areas (Hillis, 1990). False crawl ratios for hawksbill turtles doubled after the hurricane, mostly due to fallen trees and eroded root tangles blocking nesting attempts (Hillis, 1990). Other direct impacts of Hurricane Hugo on sea turtle habitats include destruction of coral reef communities important to hawksbill and green turtles. Nooks and crannies in the reef used by these turtles for resting were destroyed in some areas (Agardy, 1990). Seagrass beds, which are important foraging areas for green turtles, were widely decimated in Puerto Rico (Agardy, 1990). Indirect effects (contamination of food or poisoning of reef-building communities) on the offshore and coastal habitats of sea turtles include pollution of nearshore waters from storm-associated runoff.

Construction, vehicle traffic, beachfront erosion, and artificial lighting are activities that disturb sea turtles or their nesting beaches (Raymond, 1984; Garber, 1985). Traffic may compress nests and beach cleaning may compact or destroy nests, lowering hatching success (Coston-Clements and Hoss, 1983). Physical obstacles, such as deep tire tracks and expanded sand piles, may obstruct hatchling turtles from entering the sea or increase their stress and susceptibility to predation (Witham, 1995). Obstructions to the high water mark prevent nesting, and breakwalls are the most common and severe type of obstruction. Erosion of nesting beaches results in the loss of nesting habitat. Human interference has hastened erosion in many places. Artificial lighting from buildings, street lights, and beachfront properties may disorient hatchlings, as well as adults (Witherington and Martin, 1996). Females tend to avoid areas where beachfront lighting is most intense; turtles also abort nesting attempts more often in lighted areas. Hatchlings are attracted to lights, and may delay their entry into the sea, thereby increasing their vulnerability to terrestrial predators. Condominiums block sunlight on nesting beaches, which could presumably affect sex ratios of hatchlings (the sex of a turtle is dependent on egg temperature) by increasing the number of males produced (discussed by Mrosovsky et al., 1995). Increased human activities, such as organized turtle watches, on nesting beaches may affect nesting activity (Fangman and Rittmaster, 1994; Johnson et al., 1996).

Sea turtles can become entrained in intake pipes for cooling water at coastal power plants (NRC, 1990). An offshore intake structure may appear as suitable for resting at to some turtles, and these turtles may be subsequently drawn into a cooling system (Witham, 1995). Feeding leatherbacks probably follow large numbers of jellyfish into the intake (Witham, 1995). Deaths result from injuries sustained in transit through the intake pipe, from drowning in the capture nets, and perhaps from causes before entrainment. Mortality from entrainment in power plants is believed to be generally low, with a high number of turtle fatalities at the St. Lucie plant in southeastern Florida (NRC, 1990). Thermal effluents from power plants may cause hatchlings to become disoriented and reduce their swimming speed (O'Hara, 1980). These effluents may also degrade seagrass and reef habitats (reviewed by Coston-Clements and Hoss, 1983).

Sand mining, beach renourishment, and oil-spill cleanup operations may remove sand from the littoral zone and temporarily disturb onshore sand transport, potentially disturbing nesting activities. The main causes of permanent nesting beach loss within the GOM are the reduction of sediment transport, rapid rate of relative sea-level rise, coastal construction and development, and recreational use of accessible beaches near large population centers. Crain et al. (1995) reviewed the literature on sea turtles and beach nourishment and found certain problems repeatedly identified. For nesting females, characteristics induced by nourishment can cause (1) beach compaction, which thereby may decrease nesting success, alter nest-chamber geometry, and alter nest concealment; and (2) escarpments, which can block turtles from reaching nesting areas. For eggs and hatchlings, nourishment can decrease survivorship and affect development by altering beach characteristics such as sand compaction, gaseous environment, hydric environment, contaminant levels, nutrient availability, and thermal environment. Additionally, nests can be covered with excess sand if nourishment is implemented in areas with incubating eggs.

Human consumption of turtle eggs, meat, or byproducts occurs worldwide and depletes turtle populations (Cato et al., 1978; Mack and Duplaix, 1979). Commercial harvests are no longer permitted within continental U.S. waters, and Mexico recently banned such activity (Aridjis, 1990). Since sea turtles are highly migratory species, the taking of turtles in artisanal and commercial sea turtle fisheries is still a concern.

Chronic pollution, including industrial and agricultural wastes and urban runoff, threatens sea turtles worldwide (Frazier, 1980; Hutchinson and Simmonds, 1991). Some turtle species have lifespans exceeding 50 years (Congdon, 1989; Frazer et al., 1989) and are secondary or tertiary consumers in marine environs, creating the potential for bioaccumulation of heavy metals (Hillestad et al., 1974; Stoneburner et al., 1980; Davenport et al., 1990), pesticides (Thompson et al., 1974; Clark and Krynitsky, 1980; Davenport et al., 1990), and other toxins (Lutz and Lutcavage, 1989) in their tissues. Organochlorine pollutants have been documented in eggs, juveniles, and adult turtles (Rybitski et al., 1995). Not all species accumulate residues at the same rate; loggerheads consistently have higher levels of both PCB's and DDE than green turtles, and it has been hypothesized that the variation is due to dietary differences (George, 1997). Contaminants could stress the immune system of turtles or act as cocarcinogens indirectly by disrupting neuroendocrine functions (Colborn et al., 1993). In some marine mammals, chronic pollution has been linked with immune suppression, raising a similar concern for sea turtles.

Herbst and Jacobson (1995) and George (1997) reviewed sea turtles diseases. Green turtle fibropapillomatosis (GTFP) (debilitating tumors occurring primarily in green turtles) is a growing threat to the survival of green turtle populations worldwide (Herbst, 1994). The disease was documented in the 1930's (Smith and Coates, 1938), and its incidence has increased in the last century, especially from 1985 to 1990, in turtles found in Florida, Hawaii, and Puerto Rico. This disease may cause an increased susceptibility to marine parasites and anemia, as well as impairing feeding and swimming, increased vulnerability to entanglement, disorientation, and impaired vision or blindness (Norton et al., 1990; Barrett, 1996). Similar lesions have been reported in loggerhead turtles (Herbst, 1994). Previous studies suggest that turtles in coastal habitats with nearby human disturbance have a greater incidence of GTFP (Herbst and Klein, 1995). Turtles with GTFP are chronically stressed and immunosuppressed (Aguirre et al., 1995). Spirorchidiasis has been reported in loggerheads (Wolke et al., 1982). Severe infestations of spirorchid (blood flukes) result in emaciation, anemia, and enteritis, or conversely, emaciation and anemia could render a turtle more susceptible to spirorchid infestation. Infestations can result in death or make turtles more susceptible to mortality stemming from other stresses (Wolke et al., 1982).

Summary and Conclusion

Activities considered under the cumulative scenario may harm sea turtles and their habitats. Those activities include structure installation, dredging, water quality and habitat degradation, OCS-related trash and flotsam, vessel traffic, seismic surveys, explosive structure removals, oil spills, oil-spill response activities, natural catastrophes, pollution, dredge operations, vessel collisions, commercial and recreational fishing, human consumption, beach lighting, and power plant entrainment. Sea turtles could be killed or injured by chance collision with service vessels or eating marine debris, particularly plastic items, lost from OCS structures and service vessels. It is expected that deaths due to structure removals would rarely occur due to mitigation measures (e.g., NOAA Fisheries Observer Program). The presence of, and noise produced by, service vessels and by the construction, operation, and removal of drill rigs may cause physiological stress and make animals more susceptible to disease or predation, as well as disrupt normal activities. Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification; there is uncertainty concerning the possible effect. Oil spills and oil-spill response activities are potential threats that may be expected to cause turtle deaths. Contact with, and consumption of oil and oil-contaminated prey, may seriously impact turtles. Sea turtles have been seriously harmed by oil spills in the past. The majority of OCS activities are estimated to be sublethal (behavioral effects and nonfatal exposure to intake of OCS-related contaminants or debris). Chronic sublethal effects (e.g., stress) resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas could cause declines in survival or productivity, resulting in either acute or gradual population declines. The incremental contribution of a proposed action to cumulative impacts on sea turtles is expected to be slight.

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

This cumulative analysis considers the effects of non-OCS-related, impact-producing factors related especially to (1) alteration and destruction of habitat by dredge-and-fill activities, residential and commercial coastal construction and associated vehicular traffic, and natural catastrophes; and (2) non-OCS-related tankering spills. This cumulative discussion also considers (1) OCS-related spills related to a proposed action or connected with prior and future OCS lease sales; (2) oil-spill cleanup activities with accompanying motorized traffic; (3) predation and competition in the ecological community; and (4) beach trash and debris. The effects from these major impact-producing factors are described below. This analysis incorporates the discussion of the impacts from a proposed action on beach mice and the Florida salt marsh vole (**Chapter 4.2.1.7.**).

Present beach mice habitat is no longer of optimal quality because of historical beach erosion, construction, and tropical storm damage. Coastal construction can be expected to threaten beach mouse populations on a continual basis. Natural catastrophes including storms, floods, droughts, and hurricanes may substantially reduce or eliminate beach mice. Some of these are expected to occur and periodically contact beach mouse habitat.

Oil spills can result from import and shuttle tankering, barging, platform accidents, pipeline malfunctions, and other sources (**Table 4-15**). Spilled oil can cause skin and eye irritation, asphyxiation from inhalation of toxic fumes, food reduction, food contamination, increased predation, and displacement from preferred habitat. Contamination of food (for example, oiling of sea oat grains) may result in oil ingestion or make food tasteless or distasteful. An oil slick cannot wash over the foredunes into beach mouse habitat unless carried by a heavy storm swell. Given the probabilities of a spill occurring, persisting long enough to reach beach mouse or the Florida salt marsh vole habitat, arriving ashore near beach mice habitat coincidentally with a storm surge, and affecting beach mice or the vole, impacts of oil spills on beach mice and the vole from the cumulative scenario are expected to be low.

In the event of an oil spill, protection efforts to prevent contact of these areas with spilled oil are mandated by the Oil Pollution Act of 1990. Vehicular traffic associated with oil-spill cleanup activities may degrade preferred habitat and cause displacement from these areas.

Present beach mice habitat is no longer of optimal quality because of historical beach erosion, construction, and tropical storm damage. Coastal construction can be expected to threaten beach mouse populations on a continual basis. Natural catastrophes including storms, floods, droughts, and hurricanes may substantially reduce or eliminate beach mice. Some of these are expected to occur and periodically contact beach mouse habitat.

Predation from both feral and nonferal domestic cats and dogs and competition with common house mice may also reduce and disturb their populations, but estimates of this mortality are unreliable (USDOI, FWS, 1987; Humphrey and Frank, 1992). Domestic predators are protected by their owners against the following four factors: hunger, disease, predation, and competition. Therefore, they may be more of a threat to beach mice in terms of population sizes than are wild predators, which may have their population sizes controlled by all four factors.

Trash and debris may be mistakenly consumed by beach mice or entangle them. Efforts undertaken for the removal of marine debris or for beach restoration, such as sand replenishment, may temporarily scare away beach mice, destroy their food resources such as sea oats, or collapse the tops of their burrows.

The beach mouse has a maximum expected life span of one year. The life span of the Florida salt marsh vole is short; typically, few animals live longer than 6 months. Disturbances are not expected to last for more than one or two generations, provided some relict population survives.

Summary and Conclusion

Cumulative activities have a potential to harm or reduce the numbers of Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice, and the Florida salt marsh vole. These activities include alteration and reduction of habitat by dredge-and-fill activities, residential and commercial coastal construction and associated vehicular traffic, and natural catastrophes, oil spills stemming from import tankering, oil spills related to OCS-related activities, oil-spill response activities for both OCS-related and non-OCS-related spills. Most spills related to a proposed action, as well as oil spills stemming from import tankering and prior and future lease sales, are not expected to contact beach mice or their habitats. The expected incremental contribution of oil spill assumed in a proposed action (as analyzed in **Chapter 4.4.7.**) to the cumulative oil-spill impact (as analyzed in **Table 4-15**) is negligible. Non-OCS activities or natural catastrophes could potentially deplete some beach mice and the vole populations to unsustainable levels, especially if reintroduction of the vole could not occur.

4.5.8. Impacts on Coastal and Marine Birds

This cumulative analysis considers the effects of impact-producing factors related to a proposed action; prior and future OCS lease sales; State oil and gas activity; crude oil imports by tanker; and other commercial, military, and recreational offshore and coastal activities that may occur and adversely affect populations of nonendangered/nonthreatened and endangered/threatened birds. Air emissions; degradation of water quality; oil spills and spill-response activities; aircraft and vessel traffic and noise, including OCS helicopter and service vessels; habitat loss and modification resulting from coastal construction and development; OCS pipeline landfalls and coastal facility construction; and accidentally discarded and beached trash and debris are OCS-related sources of potential adverse impacts. Non-OCS impact-producing factors include habitat degradation; import tankering, disease; bird watching activities; interactions with fisheries, storms and floods; pollution of coastal waters resulting from municipal, industrial, and agricultural runoff and discharge; and collisions of coastal and marine birds with structures such as power line towers. This analysis incorporates the discussion of the impacts from a proposed action on coastal and marine birds (**Chapters 4.2.1.8. and 4.4.8.**) with additional information as cited.

Chapters 4.2.1.1., 4.4.1., and 4.5.1. consider air emissions including the amount of sulfur dioxide expected to be released due to a proposed action as well as related to prior and future OCS lease sales, and State oil and gas activity. These emissions may adversely affect coastal and marine birds. Pollutant emissions into the atmosphere from the activities under the cumulative analysis are projected to have minimum effects on offshore air quality because of the prevailing atmospheric conditions, emission heights, and pollutant concentrations. Onshore impact on air quality from emissions under the OCS cumulative analysis is estimated to be within both Class I and Class II PSD allowable increments as applied to the respective subareas. Emissions of pollutants into the atmosphere under the cumulative analysis are projected to have little effect on onshore air quality because of the atmospheric regime, the emission rates, and the distance of these emissions from the coastline. These judgments are based on average steady state conditions and the dispersion equation for concentration estimates; however, there would be days of low mixing heights and wind speeds that could further decrease air quality. These conditions are characterized by fog formation, which in the GOM occurs about 30-40 days a year, mostly during winter. Impacts from offshore sources are reduced in winter because the frequency of onshore winds decreases (19-34%) and the removal of pollutants by rain increases. The summer is more conducive to air quality effects as onshore winds occur more frequently, approximately 52-85 percent of the time. Increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} under the cumulative analysis are estimated to be less than Class I and Class II PSD allowable increments for the respective subareas per both the steady state and plume dispersion analyses, and they are below concentrations that could harm coastal and marine birds. Indirect impacts on coastal and marine birds due to direct impacts on air quality under the cumulative analysis would have a negligible effect on coastal and marine birds, including the three endangered species (bald eagle, brown pelican, and piping plover)

Degradation of coastal and inshore water quality resulting from factors related to a proposed action plus those related to prior and future OCS lease sales; crude oil imports by tanker; and other commercial, military, and recreational offshore and coastal activities is expected to impact coastal and marine birds. The effects of the cumulative activities scenario on coastal water quality are analyzed in detail in **Chapter 4.5.2.1.** A wide variety of contaminants enter coastal waters bordering the GOM. The dominant pollution source is the large volume of water from the Mississippi River, which drains over two-thirds of the contiguous United States. Major activities that have added to the contamination of GOM coastal waters include the petrochemical industry, agriculture, forestry, urban expansion, extensive dredging operations, municipal and camp sewerage treatment processes, marinas and recreational boating, maritime shipping, and hydromodification activities. Not as significant are large commercial waste disposal operations, livestock farming, manufacturing industry activities, nuclear power plant operations, and pulp and paper mills. Vessel traffic is likely to impact water quality through routine releases of bilge and ballast waters, chronic fuel and tank spills, trash, and domestic and sanitary discharges. **Table 4-15** show the projected number of large oil spills (≥1,000 bbl) represent an acute significant impact to coastal waters while small spills serve as a low-level, chronic source of petroleum contamination to regional coastal water quality. Turbidity in water may block visual predation on fish by brown pelicans and bald eagles. Piping plover forge at the water's edge, making them vulnerable to chronic, low-level accumulation of contaminants in beach sediment brought ashore by wave action over time.

Coastal and marine birds would likely experience chronic physiological stress from nonfatal exposure to or intake of contaminants or discarded debris. This would cause disturbances and displacement of single birds or flocks. Chronic sublethal stress is often undetectable in birds. It can serve to weaken individuals (especially serious for migratory species) making them susceptible to infection and disease. The extensive oil and gas industry operating in the GOM area has caused low-level, chronic, petroleum contamination of coastal waters. Lethal effects are expected primarily from uncontained inshore oil spills and associated spill response activities in wetlands and other biologically sensitive coastal habitats. Primary physical effects are oiling and the ingestion of oil; secondary effects are the ingestion of oiled prey. Recruitment of birds through successful reproduction is expected to take at least one breeding season, with sufficient increase in population size to offset the loss from oil spill impacts. Each breeding pair of birds must fledge more than two offspring per generation which must then survive to maturity for population size to have a net increase. Helicopter and service-vessel traffic related to OCS activities could sporadically disturb feeding, resting, or nesting behavior of birds or cause abandonment of preferred habitat. The FAA (Advisory Circular 91-36C) and corporate helicopter policy states that helicopters must maintain a minimum altitude of 700 ft while in transit offshore, and 500 ft while working between platforms. When flying over land, the specified minimum altitude is 1,000 ft over unpopulated areas or across coastlines and 2,000 ft over populated areas and biologically sensitive areas such as wildlife refuges and national parks. Generic importance of the flight altitude regulation to birds is discussed in **Chapter 4.2.1.8.**, Impacts on Coastal and Marine Birds. The net effect of OCS-related flights on coastal and marine birds is expected to result in sporadic disturbances, which may result in displacement of localized groups. During nesting periods, this could ultimately result in some reproductive failure from nest abandonment or predation on eggs and young when a parent is flushed from a nest. Bald eagle nests would be sensitive to overhead noise because they are above the forest canopy, and piping plover nests are on dunes open to the sky. Similarly, bald eagles and brown pelicans feed over open water and piping plovers feed on open beaches.

An average of 266,625-275,950 OCS-related service-vessel trips may occur annually as a result of the OCS Program in the EPA and CPA. Service vessels would use selected nearshore and coastal (inland) navigation waterways, and adhere to protocol set forth by the USCG for reduced vessel speeds within these inland areas. Routine presence and low speeds of service vessels within these waterways diminishes the effects of disturbance from service vessels on nearshore and inland populations of coastal and marine birds. It is expected that service-vessel traffic would seldom disturb populations of coastal and marine birds existing within these areas. Recreational vessel traffic is a much greater source of impact to birds in coastal habitats. These vessels are, in most cases, not required to comply with strict speed/wake restrictions (small recreational fishing boats, ski boats, etc.) and often flush coastal and marine birds from feeding, resting, and nesting areas. For example, wakes would disrupt a piping plover when it is trying to forage at the water's edge. Such disturbances displace local groups from these preferred habitats and could lead to abandonment of the areas or reproductive failure. Disturbance may result in increased energy expenditures due to avoidance flights and decreased energy intake due to interference with feeding activity. It is estimated that the effects of non-OCS vessel traffic on birds within coastal areas are substantial.

Historic census data shows that many coastal birds are declining in numbers and are being displaced from areas along the coast (and elsewhere) as a result of the encroachment of their preferred habitat(s) by the aforementioned sources. As these birds move to undisturbed areas of similar habitat, their presence may create or augment habitat utilization pressure on these selected areas as a result of intra- and interspecific competition for space and food. The endangered species are unable to produce counter-pressure because their populations are so low and often not increasing. Under the cumulative activities scenario, factors contributing to coastal landloss or modification in Louisiana, Mississippi and Alabama, include construction of approximately 19-28 OCS pipeline landfalls, 100-140 km of onshore OCS pipeline, and potentially 3-11 gas processing plants (OCS only) as well as other facilities. The contribution of development from urban and other industrial growth would be substantial, causing both the permanent loss of lands and increased levels of disturbance associated with new construction and facilities. Development interferes especially with the endangered species (bald eagle, brown pelican, and piping plover) which for now require trends of increases in populations rather than stasis and equilibrium.

Coastal and marine birds are commonly entangled and snared in discarded trash and debris. Many species would readily ingest small plastic debris, either intentionally or incidentally. Interaction with plastic materials may lead to permanent injuries and death. Much of the floating material discarded from vessels and structures offshore drifts ashore or remains within coastal waters. These materials include lost or discarded fishing gear such as gill nets and monofilament lines, which cause the greatest damage to birds. It is expected that coastal and marine birds would seldom become entangled in or ingest OCS-related trash and debris as a result of MMS prohibitions on the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which prohibits the disposal of any plastics at sea or in coastal waters, went into effect January 1, 1989. Despite these regulations, quantities of plastic materials are accidentally discarded and lost in the marine environment, and so remain a threat to individual birds within these areas. The bald eagle, brown pelican, and piping plover would share nonendangered birds' vulnerability to debris.

Non-OCS impact-producing factors include habitat degradation; water quality degradation, oil-spill and spill-response activities; disease; bird watching activities; fisheries interactions; storms and floods; pollution of coastal waters resulting from municipal, industrial, and agricultural runoff and discharge; and collisions of coastal and marine birds with structures such as power line towers. The bald eagle, brown pelican, and piping plover are favorites of bird watchers because they are rare and at least somewhat exotic. Bird watchers must be especially careful not to disturb these species. Coastal storms and hurricanes can often cause deaths to coastal birds through high winds; associated flooding destroys active nests. The brown pelican sometimes nests in scrapes in the ground, making it more vulnerable to flooding. Because the bald eagle nests in trees, it would not be vulnerable to flooding.

Nesting territories and colonial bird rookeries with optimum food and/or nest-building materials may also be lost. Elevated levels of municipal, industrial, and agricultural pollutants in coastal wetlands and waters expose resident birds to chronic physiological stress. Collisions with power lines and supporting towers are not atypical during inclement weather and during periods of migration, often causing death or permanent injury to birds (Avery et al., 1980; Avian Power Line Interaction Committee, 1994). Vital habitat needs to be protected so that the life-support system continues for the birds and their prey. Habitat alteration has the potential to disrupt social behavior, food supply, and health of birds that occur in the GOM. Such activities may stress the animals and cause them to avoid traditional feeding and breeding areas or migratory routes. Commercial fisheries operations and lost and discarded fishing gear may accidentally entangle and drown or injure birds. Competition for prey species may also occur between birds and fisheries.

Summary and Conclusion

Activities considered under the cumulative activities scenario would detrimentally affect coastal and marine birds. It is expected that the majority of effects from the major impact-producing factors on coastal and marine birds are sublethal (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris) and would usually cause temporary disturbances and displacement of localized groups inshore. The net effect of habitat loss from oil spills, new construction, and maintenance and use of pipeline corridors and navigation waterways would alter species composition and reduce the overall carrying capacity of disturbed area(s) in general.

The incremental contribution of a proposed action (**Chapter 4.2.1.8.**) to the cumulative impact on coastal and marine birds is negligible because the effects of the most probable impacts, such as lease sale-related operational discharges and helicopters and service-vessel noise and traffic, are estimated to be sublethal and some displacement of local individuals or groups may occur. It is expected that there would be little interaction between OCS-related oil spills and coastal and marine birds.

The cumulative effect on coastal and marine birds is expected to result in a discernible decline in the numbers of birds that form localized groups or populations, with associated change in species composition and distribution. Some of these changes are expected to be permanent, as exemplified in historic census data, and to stem from a net decrease in preferred and/or critical habitat.

Bald eagles, brown pelicans, and piping plovers could be affected by noise from helicopters, encroachment on wild habitat by new coastal real estate, debris, bird watching that is too careless or otherwise disturbing, and wind storms that could destroy eggs or nests. Piping plovers could be affected by the accumulation of contaminants carried ashore by wave action, and its feeding along the shoreline could be affected by wakes from passing recreational boats near shore. Bald eagles and brown pelicans could be affected by turbidity while searching for fish in the water.

4.5.9. Impacts on Endangered and Threatened Fish

4.5.9.1. Gulf Sturgeon

This cumulative analysis considers the effects of impact-producing factors related to (1) oil spills involving a proposed action and prior and future OCS lease sales; (2) dredge-and-fill operations and natural catastrophes that alter or destroy habitat; and (3) commercial fishing on the Gulf sturgeon. Sections providing supportive material for the Gulf sturgeon analysis include **Chapters 3.2.7.1.** (Gulf Sturgeon), 4.3.1. (Oil Spills), and 4.1.3. (Other Cumulative Activities Scenario).

Extant occurrences of Gulf sturgeon in 1993 extended from Lake Pontchartrain in southeastern Louisiana to Charlotte Harbor in western Florida (USDOI, FWS and Gulf States Marine Fisheries Commission, 1995). Although spawning may occur from the Pearl River in western Mississippi eastward, the most important spawning populations occur within the Florida Panhandle in the Apalachicola and Suwannee Rivers (Patrick, personal communication, 1996). Spawning grounds are located upriver during summer, not within coastal wetlands (Barkuloo, 1988; Clugston, 1991).

The direct effects of spilled oil on Gulf sturgeon occur through the ingestion of oil or oiled prey and the uptake of dissolved petroleum through the gills by adults and juveniles. Contact with or ingestion/absorption of spilled oil by adult Gulf sturgeon can result in mortality or nonfatal physiological impact, especially irritation of gill epithelium and disturbance of liver function.

The MMS estimates, for the EPA OCS Program, there is a 19-43 percent chance that there would be an offshore spill ≥1,000 bbl in the next 40 years. For spills ≥1,000 bbl, concentrations of oil below the slick are within the range that causes sublethal effects on marine organisms. The maximum observed concentration of 1.5 ppm was observed at depth of 2 m below the slick from the *Ixtoc I* blowout (McAuliffe, 1987). This value is within the range of LC_{50} values for many marine organisms; such values are typically 1-100 ppm for adults and subadults (Connell and Miller, 1980; Capuzzo, 1987). However, when exposure time beneath accidental spills, hydrocarbon composition, and the change in this composition during weathering are considered, exposure doses (measured as ppm-hr) are assumed to be far less than doses reported to cause even sublethal effects (McAuliffe, 1987).

It is expected that the extent and severity of effects from oil spills would be lessened by active avoidance of oil spills by adult sturgeon. Sturgeons are demersal and would forage for benthic prey well below an oil slick on the surface. Adult sturgeon only venture out of the rivers into the marine waters of the Gulf for roughly three months during the coolest weather. This reduces the likelihood of sturgeon coming into contact with oil. Tar balls resulting from the weathering of oil "are found floating at or near the surface" (NRC, 1985) with no effects on demersal fishes such as the Gulf sturgeon expected.

Natural catastrophes and non-OCS activities such as dredge-and-fill may destroy Gulf sturgeon habitat. Natural catastrophes including storms, floods, droughts, and hurricanes can result in substantial habitat damage. Loss of habitat is expected to have a substantial effect on the reestablishment and growth of Gulf sturgeon populations.

Dredge-and-fill activities occur throughout the nearshore areas of the United States. They range in scope from propeller dredging by recreational boats to large-scale navigation dredging and fill for land reclamation. Non-OCS operations and events such as dredge-and-fill activities and natural catastrophes, indirectly impact Gulf sturgeon through the loss of spawning and nursery habitat.

Commercial fishing techniques such as trawling, gill netting, or purse seining, when practiced nonselectively, may reduce the standing stocks of the desired target species as well as significantly impact species other than the target. Sturgeons are a small part of the shrimp bycatch. It is estimated that for every 0.5 kg of shrimp harvested, 4 kg of bycatch is discarded (Sports Fishing Institute, 1989). The death of several Gulf sturgeons is expected from commercial fishing.

Summary and Conclusion

The Gulf sturgeon can be impacted by activities considered under the cumulative scenario, activities such as oil spills, alteration and destruction of habitat, and commercial fishing. The effects from contact with spilled oil would be nonfatal and last for less than one month. Substantial damage to Gulf sturgeon habitats is expected from inshore alteration activities and natural catastrophes. Deaths of adult sturgeon are expected to occur from commercial fishing. The incremental contribution of a proposed action (as analyzed in **Chapter 4.2.1.9.1.**) to the cumulative impact on Gulf sturgeon is negligible because the effect of contact between lease sale-specific oil spills and Gulf sturgeon is expected to be nonfatal and last less than one month.

4.5.9.2. Smalltooth Sawfish

This cumulative analysis considers the effects of impact-producing factors including commercial fishing, dredge-and-fill operations, and natural catastrophes that alter or destroy habitat, oil spills, and flotsam and jetsam on the smalltooth sawfish. Sections providing supportive material for the smalltooth sawfish analysis include **Chapters 3.2.7.2.** (Smalltooth Sawfish), **4.3.1.** (Oil Spills), and **4.1.3.** (Other Cumulative Activities Scenario).

Fishing and habitat alteration and degradation in the past century have reduced the U.S. population of the smalltooth sawfish (USDOC, NMFS, 2000). At present, the smalltooth sawfish is primarily found in southern Florida in the Everglades and Florida Keys. Historically, this species was common in neritic and coastal waters of Texas and Louisiana. Many records of the smalltooth sawfish were documented in the 1950's and 1960's from the northwestern Gulf in Texas, Louisiana, Mississippi, and Alabama. Since 1971, however, there have been only three published or museum reports of the species captured in the region, all from Texas (1978, 1979, and 1984). Additionally, reports of captures have dropped dramatically. Louisiana, an area of historical localized abundance, has experienced marked declines in sawfish landings. The lack of smalltooth sawfish records since 1984 from the area west of peninsular Florida is a clear indication of their rarity in the northwestern Gulf.

Commercial fishing techniques such as trawling, gill netting, purse seining, or hook-and-line fishing may reduce the standing stocks of the desired target species as well as significantly impact species other than the target, including smalltooth sawfish. The death of some smalltooth sawfish is expected from commercial fishing.

Natural catastrophes and other activities such as dredge-and-fill may temporarily impact or alter smalltooth sawfish habitat. Storms, floods, droughts, and hurricanes can result in substantial habitat damage. Loss of habitat is expected to have an effect on the reestablishment and growth of smalltooth sawfish populations.

Dredge-and-fill activities occur throughout the nearshore areas of the U.S. They range in scope from propeller dredging by recreational boats to large-scale navigation dredging and fill for land reclamation. Non-OCS operations and events such as dredge-and-fill activities and natural catastrophes indirectly impact smalltooth sawfish through the loss of mating habitat.

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.

For spills ≥1,000 bbl, concentrations of oil below the slick are within the range that could cause sublethal effects on marine organisms. The maximum observed concentration of 1.5 ppm was observed at depth of 2 m below the slick from the *Ixtoc I* blowout (McAuliffe, 1987). This value is within the range of LC_{50} values for many marine organisms; such values are typically 1-100 ppm for adults and subadults (Connell and Miller, 1980; Capuzzo, 1987). However, when exposure time beneath accidental spills, hydrocarbon composition, and the change in this composition during weathering are considered, exposure doses (measured as ppm-hr) are assumed to be far less than doses reported to cause even sublethal effects (McAuliffe, 1987).

It is expected that the extent and severity of effects from oil spills on smalltooth sawfish would be lessened by active avoidance of oil spills.

Smalltooth sawfish could also be impacted by flotsam and jetsam resulting from OCS activities, shipping, and commercial and recreational fishing. The fish could become entangled in or ingest debris resulting in injury or death.

Summary and Conclusion

The smalltooth sawfish could be impacted by several factors considered under the cumulative scenario, including commercial and recreational fishing, alteration and destruction of habitat, oil spills, and flotsam and jetsam. The effects from contact with spilled oil would most likely be nonfatal and of short duration. Damage to smalltooth sawfish habitat is likely due to habitat alteration and natural catastrophes, which could contribute to the continued decline and displacement of their populations. Most deaths of smalltooth sawfish are expected to occur from commercial fishing.

Because the current population of smalltooth sawfish is primarily found in southern Florida in the Everglades and Florida Keys, impacts to these animals due to routine activities or accidental events associated with a proposed action are expected to be negligible.

4.5.10. Impacts on Fish Resources and Essential Fish Habitat

This cumulative analysis considers activities that could occur and adversely affect fish resources and EFH in the northern GOM during the years 2003-2042. These activities include effects of the OCS Program (a proposed action, and prior and future OCS lease sales), State oil and gas activity, coastal development, crude oil imports by tanker, commercial and recreational fishing, and natural phenomena. Specific types of impact-producing factors considered in this cumulative analysis include coastal environmental degradation; marine environmental degradation; commercial and recreational fishing techniques or practices; hypoxia; red or brown tides; hurricanes; removal of production structures; petroleum spills; subsurface blowouts; pipeline trenching; and offshore discharges of drilling muds and produced waters.

Healthy fishery stocks depend on EFH waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Due to the wide variation of habitat requirements for all life history stages for marine species (as described in **Chapter 3.2.8.2.**), EFH for the GOM includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the EEZ. The effects of cumulative actions on coastal wetlands and coastal water quality are analyzed in detail in **Chapters 4.5.3.2. and 4.5.2.1.**, respectively. Collectively, the adverse impacts from these effects are called coastal environmental degradation. The effects of cumulative actions on offshore live bottoms and marine water quality are analyzed in detail in **Chapters 4.5.4.1.1. and 4.5.2.2.**, respectively. Collectively, the adverse impacts from these effects are called marine environmental degradation. The direct and/or indirect effects from cumulative coastal and marine environmental degradation on fish resources and EFH are summarized and considered below.

Conversion of wetlands for agricultural, residential, and commercial uses has been substantial. The trend is projected to continue into the future, although at a slower rate in consideration of regulatory pressures. The most serious impact to EFH is the cumulative effects on wetlands that are occurring at an ever-increasing rate as the Gulf Coast States' populations increase (GMFMC, 1998). Residential, commercial, and industrial developments are directly impacting EFH by dredging and filling coastal areas or by affecting the watersheds.

The cumulative impacts of pipelines to wetlands are described in **Chapter 4.5.3.2.** Permitting agencies require mitigation of many of these impacts. Unfortunately, many of these efforts are not as productive as intended. The MMS and USGS are performing a study of these problems to help identify solutions.

Canal dredging primarily accommodates commercial, residential, and recreational development. Increased population and commercial pressures on the coasts of Texas, Louisiana, Mississippi, and Alabama are also causing the expansion of ports and marinas there. Where new channels are dredged, wetlands would be adversely impacted by the channel, disposal of dredged materials, and the development that it attracts.

The continuing erosion of waterways maintained by COE is projected to adversely impact productivity of wetlands along channel banks. Expansion of tidal influence, saltwater intrusion, hydrodynamic alterations, erosion, sediment export, and habitat conversion can be significant in basins with low topographic relief, as seen in deltaic Louisiana. Secondary impacts are projected to generate the loss of wetlands over the next 30-40 years, primarily in Louisiana.

Other factors that impact coastal wetlands include marsh burning, marsh-buggy/airboat traffic, and well-site construction. The practice of marsh buggy/airboat use in marsh areas is far less common than in years past. Tracks left by marsh buggies open new routes of water flow through relatively unbroken marsh and can persist for up to 30 years, thereby inducing and accelerating erosion and sediment export. Well-site construction activities include board roads, ring levees, and impoundments.

Conversion of wetland habitat is projected to continue in the foreseeable future. Within the northern GOM coastal areas, river channelization and flood protection have greatly restricted the most effective wetland creation activities. Flood control has fostered development, which has impacted wetlands the most and reduced their area.

State oil production and related activities, especially in Texas, Louisiana, and Alabama, are projected to have greater and more frequent adverse impacts on wetlands than would the OCS Program offshore activities, because of their proximity. Construction of new facilities would be more closely scrutinized, although secondary impacts on wetlands would continue to be the greatest and should receive greater attention.

The present number of major navigation canals appears to be adequate for the OCS Program and most other developments. Some of these canals may be deepened or widened. Navigation canal construction would continue in coastal Louisiana and would be an important cause of wetland loss there. Secondary impacts of canals to wetlands would continue to cause impacts.

The incremental contribution of a proposed action (**Chapter 4.2.1.3.2.**) would be a very small part of the cumulative impacts to wetlands. Offshore live bottoms would not be impacted.

The coastal waters of Texas, Louisiana, Mississippi, Alabama, and the Florida Panhandle are expected to continue to experience nutrient over enrichment, low-dissolved oxygen, and toxin and pesticide contamination, resulting in the loss of both commercial and recreational uses of the affected waters. Fish kills, shellfish-ground closures, and restricted swimming areas would likely increase in numbers over the next 30-40 years (although some areas have seen improvements and re-opened for swimming, such as Lake Pontchartrain). Degradation of water quality is expected to continue due to contamination by point- and nonpoint-source discharges and spills due to eutrophication of waterbodies, primarily due to runoff and hydrologic modifications. Contamination of the coastal waters by natural and manmade noxious compounds coming from point and nonpoint sources and accidental spills derived from both rural and urban sources would be both localized and pervasive. Runoff and wastewater discharge from these sources would cause water quality changes that would result in a significant percentage of coastal waters not attaining Federal water quality standards. Increased turbidity from extensive dredging operations projected to continue within the coastal zone constitutes another considerable type of pollution. Contamination from oil and hazardous substance spills should be primarily localized and not long term enough to preclude designated uses of the waters.

The incremental contribution of a proposed action (**Chapter 4.2.1.2.1.**) would be a very small part of the cumulative impacts to coastal water quality. Localized, minor degradation of coastal water quality is expected from a proposed action within the immediate vicinity of the waterbodies proximate to the proposed service bases, commercial waste-disposal facilities, and gas processing plants as a result of routine effluent discharges and runoff. Only a very small amount of dredging would occur as a result of a proposed action.

Non-OCS sources of impacts on biological resources and the structure of live bottoms include natural disturbances (e.g., turbidity, hypoxia, and storms), anchoring by recreational and commercial vessels, and commercial and recreational fishing. These impacts may result in severe and permanent mechanical damage to live-bottom communities.

Commercial fishing activities that could impact live bottoms would include trawl fishing and trap fishing. With the exception of localized harvesting techniques, most wild-caught shrimp are collected using bottom trawls – nets towed along the seafloor – held apart with heavy bottom sled devices called "doors" made of wood or steel. In addition to the nonselective nature of bottom trawls, they can be potentially damaging to the bottom community as they drag. Trawls pulled over the bottom disrupt the communities that live on and just below the surface and also increases turbidity of the water (GMFMC, 1998).

Throughout the Gulf Coast, commercial trap fishing is used for the capture of reef fish while commercial and recreational trap fishing is used for the capture of spiny lobster, stone crab, and blue crab. Reef fish traps are primarily constructed of vinyl-covered wire mesh and include a tapered funnel where the fish can enter but not escape. Traps, like trawls, can potentially damage the bottom community, depending on where they are placed. If they are deployed and retrieved from coral habitats or live bottom, they can damage the corals and other attached invertebrates on the reef. Seagrasses can also be broken or killed by placement and retrieval of traps (GMFMC, 1998).

The OCS-related activities (other than those related to a proposed action) could impact the biological resources and the structure of live bottoms by the anchoring of vessels, emplacement of structures (drilling rigs, platforms, and pipelines), sedimentation (operational waste discharges, pipeline emplacement, explosive removal of platforms, and blowouts), and chemical contamination (produced water, operational waste discharges, and petroleum spills). The Live Bottom (Pinnacle Trend) Stipulation (in the CPA), and the Topographic Features Stipulation (in the CPA and WPA) would prevent most of the potential impacts on live-bottom communities and EFH from the OCS Program and from bottom-disturbing activities (anchoring, structure emplacement and removal, pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, produced waters), and blowouts. Recovery from impacts caused by unregulated operational discharges or an accidental blowout would take several years. For any activities associated with a proposed action, USEPA's Region 4 would regulate discharge requirements through their USEPA NPDES individual discharge permits. In the unlikely event of an offshore spill, the biological resources of hard/live bottoms would remain unharmed as the spilled substances could, at the most, reach the seafloor in minute concentrations. These minute quantities may cause very short-term sublethal effects (changes in physiology) in benthic organisms that would recover quickly.

Surface oil spills from OCS Program-related activities would have the greatest chance of impacting high relief live bottoms (includes topographic features and pinnacles) located in depths less than 20 m (mostly sublethal impacts). Most of the pinnacle trend is well mapped and described (**Chapter 3.2.2.1.1.**, Live-Bottom (Pinnacle Trend)). Subsurface spills (pipeline spills) could cause localized, sublethal (short-term, physiological changes) impacts on the live bottoms; however, such events would be highly unlikely since the protective lease stipulations would prevent oil lines from being installed in the immediate vicinity of high-relief live bottoms. The impact of OCS-related activities on the live bottoms of the cumulative activity area would probably be slight because community-wide impacts should not occur.

The incremental contribution of a proposed action to the cumulative impacts on fisheries and EFH (as analyzed in **Chapters 4.2.1.10. and 4.4.10.**) would be small. A proposed action would add slightly to the overall offshore water quality degradation through the disposal of offshore operational wastes and sedimentation/sediment resuspension. Other activities of a proposed action potentially contributing to regional impacts would be the effects of petroleum spills and anchoring. The extent of these impacts would be limited by the implementation of the protective lease stipulations and the depths of all but three high-relief live bottom habitats (>20 m).

Municipal, agricultural, and industrial coastal discharges and land runoff would impact the health of marine waters. As the assimilative capacity of coastal waters is exceeded, there would be a subsequent, gradual movement of the area of degraded waters farther offshore over time. This degradation would cause short-term loss of the designated uses of some shallow offshore waters due to hypoxia and red or brown tide impacts and to levels of contaminants in some fish exceeding human health standards. Coastal sources are assumed to exceed all other sources, with the Mississippi River continuing to be the major source of contaminants to the north-central GOM area. Offshore vessel traffic and OCS operations would contribute in a small way to regional degradation of offshore waters through spills and waste discharges. All spill incidents (OCS and others) and activities increasing water-column turbidity are assumed to cause localized water quality changes for up to three months for each incident. The incremental contribution of a proposed action to degradation of marine water quality would be small.

It is expected that coastal and marine environmental degradation from the OCS Program and non-OCS activities would affect fish populations and EFH. The impact of coastal and marine degradation is expected to cause no more than a 10 percent decrease in fish populations or EFH. At the expected level of cumulative impact, the resultant influence on fish resources and EFH could be substantial and easily distinguished from effects due to natural population variations. The incremental contribution of a proposed action to these cumulative impacts would be small and almost undetectable.

Competition between large numbers of commercial and recreational fishermen for a given fishery resource, as well as natural phenomena such as weather, hypoxia, and red or brown tides, may reduce fish resource standing populations. Fishing techniques such as trawling, gill netting, or purse seining, when practiced nonselectively, may reduce the standing stocks of the desired target species as well as significantly impact species other than the target. Hypoxia and red or brown tides may impact fish resources and EFH by suffocating or poisoning offshore populations of finfish and shellfish and live-bottom reef communities. Finally, hurricanes may impact fish resources by destroying offshore live-bottom and reef communities and changing physical characteristics of inshore and offshore ecosystems. Since the only targeted game fish would be highly migratory pelagic species, these other cumulative factors described above would have very little impact on these species in the proposed lease sale area. Commercial and recreational fishing practices would have little if any direct impact on EFH as the only EFH targeted in the action area is the pelagic environment. Fishing activities have little effect on the water body (EFH) itself.

Many of the important species harvested from the GOM are believed to have been overfished, while overfishing is still taking place (USDOC, NMFS, 2001a). Four new managed species are listed as overfished in 2000 that were not listed in 1999. Continued fishing at the present levels may result in declines of fish resource populations and eventual failure of certain fisheries. It is expected that overfishing of targeted species and trawl fishery bycatch would adversely affect fish resources. The impact of overfishing on fish resources is expected to cause a measurable decrease in populations. At the estimated level of effect, the resultant influence on fish resources is expected to be substantial and easily distinguished from effects due to natural population variations.

Those species that are not estuary dependent, such as mackerel, cobia, and crevalle, are considered coastal pelagics. Populations of these species exhibit some degree of coastal movement. These species range throughout the GOM, move seasonally, and are more abundant in the eastern portions of the northern GOM during the summer (GMFMC, 1985). In general, the coastal movements of these species are restricted to one or two regions within the GOM and are not truly migratory, as is the case with salmon. The coastal movements of these species are related to reproductive activity, seasonal changes in water temperature, or other oceanographic conditions. Discernible effects to regional populations or subpopulations of these species as a result of the OCS Program in the GOM are not expected because pelagic species are distributed and spawn over a large geographic area and depth range.

Structure removals would result in artificial habitat loss. It is estimated that 5,350-6,110 structures would be removed as a result of the OCS Program in the CPA and 10-12 structures would be removed in the EPA. No explosive removal techniques would be used in the EPA (**Chapter 4.1.1.11.**, Decommissioning and Removal Operations). It is expected that structure removals would have a major effect on fish resources near the removal sites. However, only those fish proximate to sites removed by explosives (outside of the EPA) would be killed; these expected impacts to fish resources have been shown to be small overall and would not alter determinations of status for impacted species or result in changes in management strategies (Gitschlag et al., 2000).

In the following analysis, the estimates of impacts to fish resources from petroleum spills comes from examinations of recent spills such as the North Cape, Breton Point, Sea Empress, and Exxon Valdez (Brannon et al., 1995; Maki et al., 1995; Mooney, 1996; Pearson et al., 1995). The amount of petroleum spilled by each event and its estimated impact to fish resources were used as a guideline to estimate the impacts to fisheries in this EIS.

Spills that contact coastal bays, estuaries, and offshore waters when pelagic eggs and larvae are present have the greatest potential to affect fish resources. If spills were to occur in coastal bays, estuaries, or waters of the OCS proximate to mobile adult finfish or shellfish, the effects would likely be nonfatal and the extent of damage would be reduced due to the capability of adult fish and shellfish to avoid a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. For eggs and larvae contacted by spilled diesel, the effect is expected to be lethal.

It is estimated that 1,875 coastal spills of <1,000 bbl would occur along the northern GOM coast annually (**Table 4-15**). About 95 percent of these spills are projected to be from non-OCS-related activity. Of coastal spills <1,000 bbl, the assumed size is 6 bbl therefore, the great majority of coastal spills would affect a very small area and dissipate rapidly. The small coastal spills that do occur from OCS-related activity would originate near terminal locations in the coastal zone of Texas, Louisiana, Mississippi, and Alabama but primarily within the Houston/Galveston area of Texas and the deltaic area of Louisiana. It is expected that small coastal oil spills from non-OCS sources would affect coastal bays and marshes essential to the well-being of the fish resources and EFH.

It is estimated that 10-15 coastal spills ≥1,000 bbl from all sources would occur annually along the northern GOM (**Table 4-15**). Between 80 and 100 percent of these spills are expected to be non-OCS related (**Table 4-15**). One large coastal spill is projected to originate from OCS-related activity every 1 to 2 years. A large coastal spill that could occur from OCS-related activity would likely originate near terminal locations in the coastal zone of Texas, Louisiana, Mississippi, or Alabama, but primarily within the Houston/Galveston area of Texas and the deltaic area of Louisiana. It is expected that large coastal spills from non-OCS sources would affect coastal bays and marshes essential to the well-being of the fishery resources and EFH in the cumulative proposed lease sale area.

A total of 4-5 large (≥1,000 bbl) offshore spills are projected to occur annually from all sources Gulfwide. Of these offshore spills, one is estimated to occur every 1 to 2 years from the Gulfwide OCS Program (**Table 4-15**). A total of 1,550 to 2,150 smaller offshore spills (<1,000 bbl) are projected annually Gulfwide. The majority of these (1,350-1,900) would originate from OCS program sources. **Chapter 4.3.1.1.2.** describes projections of future spill events in more detail. The OCS-related spills in the cumulative area are expected to cause a 1 percent or less decrease in fish resources. The impact of non-OCS-related spills in this area is expected to cause a 10 percent or less decrease in fish resources.

Subsurface blowouts of both oil and natural gas wells and pipeline trenching have the potential to affect adversely commercial fishery resources. Loss of well control and resultant blowouts seldom occur on the GOM OCS (7 blowouts per 1,000 well starts; <10% would result in some spilled oil). Considering the entire OCS program from 2003 to 2042, it is projected that there would be 164-192 blowouts in the CPA, and 1 blowout in the EPA.

Sediment would be resuspended during the installation of pipelines. Sandy sediments would be quickly redeposited within 400 m of the trench, and finer sediments would be widely dispersed and redeposited over a period of hours to days within a few thousand meters of the trench. Resuspension of vast amounts of sediments due to hurricanes occurs on a regular basis in the northern GOM (Stone et al., 1996). It is expected that the infrequent subsurface blowout that may occur on the GOM OCS would have a negligible effect on fish resources. The effect on fish resources from pipeline trenching is expected to cause a 5 percent or less decrease in standing stocks. Drilling-mud discharges contain chemicals toxic to marine fishes; however, this is only at concentrations four or five orders of magnitude higher than those found more than a few meters from the discharge point. Offshore discharges of drilling muds would dilute to very near background levels within 1,000 m of the discharge point and would have a negligible effect on fisheries. Biomagnification of mercury in large fish high in the food chain is a problem in the GOM but the bioavailability and any association with trace concentrations of mercury in discharged drilling mud has not been demonstrated. Produced-water discharges contain components and properties detrimental to commercial fishery resources. Moderate petroleum and metal contamination of sediments and the water column would occur out to several hundred meters downcurrent from the discharge point. Offshore discharges of produced water would disperse, dilute to very near background levels within 1,000 m of the discharge point, and have a negligible effect on fisheries. Offshore live bottoms would not be impacted. Offshore discharges and subsequent changes to marine water quality would be regulated by a USEPA NPDES permits.

Summary and Conclusion

Activities resulting from the OCS Program and non-OCS events in the northern GOM have the potential to cause detrimental effects on fish resources and EFH. Impact-producing factors of the cumulative scenario that are expected to substantially affect fish resources and EFH include coastal and marine environmental degradation, overfishing, petroleum spills, and pipeline trenching. At the estimated level of cumulative impact, the resultant influence on fish resources and EFH is expected to be substantial, but not easily distinguished from effects due to natural population variations.

The incremental contribution of a proposed action's impacts on fish resources and EFH (as analyzed in **Chapters 4.2.1.10. and 4.4.10.**) to the cumulative impact is small. The effects of impact-producing factors (coastal and marine environmental degradation, petroleum spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters) related to a proposed action are expected to be negligible (resulting in less than a 1% decrease in fish populations or EFH) and almost undetectable among the other cumulative impacts.

The cumulative impact is expected to result in a less than 10 percent decrease in fish resource populations or EFH. It would require 2-3 generations for fishery resources to recover from 99 percent of the impacts. Recovery cannot take place from habitat loss.

4.5.11. Impacts on Commercial Fishing

This cumulative analysis considers activities that could occur and adversely affect commercial fishing for the years 2003-2042. These activities include effects of the OCS Program (proposed action and prior and future OCS lease sales), State oil and gas activity, the status of commercial fishery stocks, oil transport by tankers, natural phenomena, and commercial and recreational fishing. Specific types of impact-producing factors considered in this cumulative analysis include commercial and recreational fishing techniques or practices, hurricanes, installation of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, petroleum spills, subsurface blowouts, and offshore discharges of drilling muds and produced waters.

Competition between large numbers of commercial fishermen, between commercial operations employing different fishing methods, and between commercial and recreational fishermen for a given fishery resource, as well as natural phenomena such as hurricanes, hypoxia, and red or brown tides, may impact commercial fishing activities. Fishing techniques such as trawling, gill netting, longlining, or purse seining, when practiced nonselectively, may reduce the standing stocks of the desired target species as well as significantly impact species other than the target. Longlining is the only applicable technique in the proposed lease sale area and is limited to about 38 percent of the proposed lease sale area. In addition, continued fishing of most commercial species at the present levels may result in rapid declines in commercial landings and eventual failure of certain fisheries. These effects would likely result in State and Federal constraints, such as closed seasons, additional excluded areas, quotas, size and weight limits on catch, and gear restrictions on commercial fishing activity.

Space-use conflicts and conflicts over possession of the resources can result from different forms of commercial operations and between commercial and recreational fisheries. These effects would likely result in State and Federal constraints, such as weekday only, quotas, and/or gear restrictions, on commercial fishing activity. Finally, hurricanes may impact commercial fishing by damaging gear and shore facilities and dispersing resources over a wide geographic area. The availability and price of key supplies and services, such as fuel, can also affect commercial fishing. The impact from the various factors described above is expected to result in a 10 percent or less decrease in commercial fishing activity, landings, or value of landings.

A range of 5-9 structures is projected to be installed as a result of the OCS Program in the EPA. If all of the proposed EPA structures are major production structures 54 ha (6 ha per platform) would be eliminated from trawl fishing for up to 40 years in the EPA. This cumulative impact, however, is not relevant for trawling activity in the proposed lease sale area due to the extreme water depths. Space-use conflicts for longline fishing could occur, but is limited to 96 blocks located south of 28 degrees North Latitude marking the boundary of a longline closure area encompassing the remainder of a proposed action area. Structure removals would result in artificial habitat loss. It is estimated that 10-12 structures would be removed from the EPA. No explosive removal techniques would be used in the EPA (**Chapter 4.1.1.11.**, Decommissioning and Removal Operations). It is expected that structure removals would have a negligible effect on commercial fishing because of the inconsequential number of removals.

Seismic surveys would occur in both shallow and deepwater areas of the GOM under the OCS Program. Usually, fishermen are precluded from a very small area for several days. This should not impact the annual landings or value of landings for commercial fisheries in the GOM. The GOM species can be found in many adjacent locations and GOM commercial fishermen do not fish in one locale. Gear conflicts between seismic surveys and commercial fishing are also mitigated by the FCF. All seismic survey locations and schedules are published in the USCG Local Notice to Mariners, a free publication available to all fishermen. Seismic surveys would have a negligible effect on commercial fishing.

The potential causes, sizes, and probabilities of petroleum spills that could occur during activities associated with a proposed action are discussed in **Chapters 4.3.1.2.**, Risk Charaterization for Proposed Action Spills. Information on spill response and cleanup is contained in **Chapter 4.3.1.2.2.5.** In the following analysis, the estimations of impacts to fisheries from oil spills come from examinations of recent spills such as the *North Cape*, *Breton Point*, *Sea Empress*, and *Exxon Valdez* (Brannon et al., 1995; Maki et al., 1995; Mooney, 1996; Pearson et al., 1995). The amount of oil spilled by each event and its estimated impact on fishing practices and fisheries economics were used as a guideline to estimate the impacts on commercial fishing under the OCS Program.

It is estimated that 1,875 coastal spills of <1,000 bbl would occur along the northern Gulf Coast annually (**Table 4-15**). About 95 percent of these spills are projected to be from non-OCS-related activity. Of coastal spills <1,000 bbl, the assumed size is 6 bbl; therefore, the great majority of coastal spills would affect a very small area and dissipate rapidly. The small coastal spills that do occur from OCS-related activity would originate near terminal locations in the coastal zone of Texas, Louisiana, Mississippi, and Alabama, but primarily within the Houston/Galveston area of Texas and the deltaic area of Louisiana. It is expected that small, coastal oil spills from non-OCS sources would affect coastal bays and marshes. Commercial fishermen would actively avoid the area of a spill. Even if fish resources successfully avoid spills, tainting (oily-tasting fish), public perception of tainting, or the potential of tainting commercial catches would prevent fishermen (either voluntarily or imposed by regulation) from initiating activities in the spill area. This in turn could decrease landings and/or value of catch for several months.

It is estimated that 10-15 coastal spills ≥1,000 bbl would occur annually along the GOM (**Table 4-15**). Between 80 and 100 percent of these spills are expected to be non-OCS related. One large coastal spill is projected to originate from OCS-related activity annually. A large coastal spill that could occur from OCS-related activity would likely originate near terminal locations in the coastal zone of Texas, Louisiana, Mississippi, or Alabama, but primarily within the Houston/Galveston area of Texas and the deltaic area of Louisiana. It is expected that large coastal spills from non-OCS sources would affect coastal bays and marshes essential to the well-being of the commercial fishery resources in the cumulative activity area.

A total of 4-5 large (≥1,000 bbl) offshore spills are projected to occur annually from all sources Gulfwide. Of these offshore spills, one spill is estimated to occur every 1 to 2 years from the Gulfwide OCS Program (**Table 4-15**).

A total of 1,550-2,150 smaller offshore spills (<1,000 bbl) are projected annually Gulfwide. The impact of OCS-related spills in the cumulative area is expected to cause less than a 1 percent decrease in commercial fishing due to the limited area where commercial fishing would take place in the southern portion of the proposed lease sale area. The impact of non-OCS-related spills in this area is expected to cause a 10 percent or less decrease in commercial fishing. At the expected level of impact, the resultant influence on commercial fishing, landings, and the value of those landings is expected to be considerable for the entire GOM, but very limited in the proposed lease sale area and not easily distinguished from effects due to natural population variations.

Subsurface blowouts of both oil and natural gas wells and pipeline trenching have the potential to adversely affect commercial fishery resources. Loss of well control and resultant blowouts seldom occur on the GOM OCS (7 blowouts per 1,000 well starts; <10% would result in some spilled oil). Considering the entire OCS Program from 2003 to 2042, it is projected that there would be 164-192 blowouts in the CPA, and 1 blowout in the EPA.

Sediment would be resuspended during the installation of pipelines, but pipelines would not be buried within, or in close proximity to the proposed lease sale area due to water depth. Resuspension of sediments due to hurricanes would not occur in the proposed lease sale area due to water depth. It is expected that the infrequent subsurface blowout that may occur on the GOM OCS would have a negligible effect on commercial fishing, particularly when limited to the smaller 96-block southern area open to commercial longlining. No pipeline trenching would occur in the proposed lease sale area due to water depth, therefore, no impacts to commercial fishing would occur. At the estimated level of effect, the resultant influence on commercial fishing is not expected to be easily distinguished from effects due to natural population variations.

Drilling-mud discharges contain chemicals toxic to marine fishes; however, this is only at concentrations four or five orders of magnitude higher than those found more than a few meters from the discharge point. Offshore discharges of drilling muds would dilute to very near background levels within 1,000 m of the discharge point and would have a negligible effect on fisheries. There are no commercially targeted benthic fish species in the proposed lease sale area.

Produced-water discharges contain components and properties detrimental to commercial fishery resources. Moderate petroleum and metal contamination of sediments and the water column would occur out to several hundred meters downcurrent from the discharge point. Offshore discharges of produced water would disperse, dilute to very near background levels within 1,000 m of the discharge point, and have a negligible effect on fisheries.

Summary and Conclusion

Activities resulting from the OCS Program and non-OCS events have the potential to cause detrimental effects to commercial fishing, landings, and the value of those landings. Impact-producing factors of the cumulative scenario that are expected to substantially affect commercial fishing include commercial and recreational fishing techniques or practices, installation of production platforms, production platform removals, seismic surveys, petroleum spills, subsurface blowouts, and offshore discharges of drilling muds and produced waters. At the estimated level of cumulative impact, the resultant influence on commercial fishing, landings, and the value of those landings is expected to be substantial for the GOM as a whole, but very small in the proposed lease sale area and not easily distinguished from effects due to natural population variations.

The incremental contribution of a proposed action to cumulative commercial fisheries impacts (as analyzed in **Chapters 4.2.1.11. and 4.4.10.**) is small. The effects of impact-producing factors (installation of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, oil spills, subsurface blowouts, and offshore discharges of drilling muds and produced waters) related to a proposed action are expected to be negligible (less than a 1% decrease in commercial fishing, landings, or value of those landings) and almost undetectable among the other cumulative impacts.

The cumulative impact is expected to result in a less than 10 percent decrease in commercial fishing, landings, or the value of those landings. It would require 3-5 years for fishing activity to recover from 99 percent of the impacts.

4.5.12. Impacts on Recreational Fishing

This cumulative analysis considers existing recreational and commercial fishing activity, artificial reef developments, fishery management, and past and future oil and gas developments. As indicated in the other sections on recreational fishing, sport fishing is a very popular recreational activity throughout the GOM and is a major attraction in support of the significant tourism economies along the Louisiana, Alabama, and Florida coastal areas. The latest information indicates participation in marine recreational fishing in the GOM is beginning to show annual increases since 1997 (USDOC, NMFS, 1999c).

In many instances throughout the GOM, competition between commercial and recreational fishermen and among fishermen targeting the same species has led to depleted fish stocks and habitat alterations. National concern for the health and sustainability of marine fisheries led to Federal legislation over 25 years ago that has resulted in the development of fishery management plans affecting recreational fish species in the GOM. Fisheries management plans focused on targeted species, such as red snapper, have led to size and creel limits as well as seasonal closures and gear restrictions or modifications in both commercial and recreational fishing. Recent amendments to the Magnuson Fishery Conservation and Management Act require that fishery management plans also identify essential fish habitat so that it might also be protected from fishing, other coastal and marine activities, and developments.

All Gulf States have aggressively supported artificial reef development programs to help encourage and increase interest and enjoyment in offshore recreational fishing. Alabama, for example, has permitted over 1,000 mi^2 of offshore area for artificial reef development and has cooperated with the military and other Federal agencies in acquiring materials such as tanks, ships, and oil and gas structures for reef development and enhancement. Although the structures associated with a proposed action would act as artificial reefs, recreational fishermen, due to the water depths of the proposed lease sale area, would target pelagic, highly migratory species such as tuna. Operators may request from the Coast Guard that safety zones be implemented around these deepwater structures. This would restrict fishermen approaching the platforms closer than 500 m. Current Coast Guard policy applies only to vessels greater than 100 feet in length, which does not apply to most recreational fishing vessels, even those that would make the long journey to the proposed lease sale area. Even though all of the structures (4-7) that are projected to be installed in the proposed lease sale area would be in deepwater, the upper portions of these structures would support encrusting organisms, while the whole structure would attract numerous species of fish including pelagic species. Although several active OCS leases exist within the proposed lease sale area, only one site currently has production structures (DeSoto Canyon Blocks 133 and 177). No active production platforms exist directly off the coast of Florida. Approximately 400 oil and gas platforms are in Federal waters east of the Mississippi River, and they have had a dramatic and long-term effect on offshore fish and fishing. The number of offshore platforms is estimated to decrease in the future (removals would outpace installations). Although it is known that fish abundance and species composition can change dramatically with platform size, location, and season of the year, Stanley (1996) has suggested that the average major platform can harbor over 20,000 fish. The fish range out in proximity to the structure and are concentrated throughout the water column, mainly in the top 200-ft of water. The fish become scarce at depths below 200 ft. Through the NOAA Fisheries Statistics Survey, Witzig (1986) estimated that over 70 percent of all recreational fishing trips that originated in Louisiana and extended more than 3 mi from shore targeted oil and gas structures for recreational fishing. It is not clear if recreational fishermen would make excursions as far as would be necessary to reach deepwater structures in the proposed lease sale area (at least 70 nmi from the nearest Louisiana shoreline and 93 nmi from the Alabama coast.)

Recreational fishing boats inadvertently contacting spills or pollution caused by accidents associated with OCS or non-OCS could be soiled, which may require the fishermen to temporarily modify their fishing plans. Spills are unlikely to decrease recreational fishing activity but may divert the location or timing of a few planned fishing trips.

Summary and Conclusion

Recreational fishing continues to be a popular nearshore and offshore recreational activity in the northeastern and central GOM. Concern for the sustainability of fish resources and marine recreational fishing has led to Federal legislation that established a fisheries management process that will include the identification and protection of essential fish habitat. The incremental contribution of a proposed action (as analyzed in **Chapters 4.2.1.12. and 4.4.11.**) to the cumulative impact on recreactional fishing is positive, although limited due to the relatively small number of structures projected for the next 40 years. Implementation of a proposed action would attract some private and charter-boat recreational fishermen farther offshore to the vicinity of the developed lease tracts in pursuit of targeted species known to be associated with petroleum structures in deep water.

4.5.13. Impacts on Recreational Resources

This cumulative analysis considers the effects of impact-producing factors related to a proposed action (**Chapters 4.2.1.13. and 4.4.12.**), plus those related to prior and future OCS lease sales, State offshore and coastal oil and gas activities throughout the GOM, tankering of crude oil imports, merchant shipping, commercial and recreational fishing, military operations, recreational use of beaches, and other offshore and coastal activities that result in trash and pollution which may adversely affect major recreational beaches. Specific OCS-related impact-producing factors such as the physical presence of platforms and drilling rigs, trash from those structures, support vessels, helicopters, oil spills, and spill cleanup activities are analyzed. Land development, engineering projects, and natural phenomena also affect, and would continue to affect, the quality of recreational beaches. Ultimately, all these factors plus the health of the U.S. economy and the price of gasoline influence the travel and tourism industry and the level of beach use along the Gulf Coast.

Trash and debris are a recognized problem affecting enjoyment and maintenance of recreational beaches along the Gulf Coast. From extensive aerial surveys conducted by NOAA Fisheries over large areas of the GOM, floating offshore trash and debris was characterized by Lecke-Mitchell and Mullin (1997) as a ubiquitous, Gulfwide problem. Coastal and offshore oil and gas operations contribute to trash and debris washing up on Texas and Louisiana beaches (Miller and Echols, 1996; Lindstedt and Holmes, 1988). Other activities, such as offshore shipping, fishing, petroleum extraction in State waters, and onshore recreation, State onshore oil and gas activities, condominiums and hotels, also add to beach debris and pollution. In addition, natural phenomena such as storms, hurricanes, and river outflows can wreak havoc on shorelines. Annual reports on the International Beach Cleanup each fall (Center for Marine Conservation, 1996-2001) show that volunteers remove thousands of pounds of trash and debris from coastal recreational beaches from Texas to Florida. Regulatory, administrative, educational, and volunteer programs involving government, industry, environmental, school, and civic groups; specific marine user groups; and private citizens are committed to monitoring and reducing the beach litter problem.

The OCS oil and gas industry has improved offshore waste management practices and shown a strong commitment to participate in the annual removal of trash and litter from recreational beaches affected by their offshore operations. Furthermore, MARPOL Annex V and the special efforts to generate cooperation and support from all GOM Program user groups should lead to a decline in the overall level of human-generated trash adversely affecting recreational beaches throughout the GOM.

At present, there are about 200 platforms within visibility range (approximately 12 mi) of shore, east of the Mississippi River to Alabama. Less than 50 OCS platforms are within 12 mi of the Mississippi or Alabama coast. This number would drastically decrease during the 40-year analysis period as structures are removed and operations move into deeper water. State oil and gas operations Louisiana and Alabama are also visible from shore. The visible presence of offshore drilling rigs and platforms are unlikely to affect the level of beach recreation, but may affect the experience of some beach users, especially at beach areas such as the Gulf Islands National Wilderness Area on Mississippi's barrier islands.

Some OCS-related vessel and helicopter traffic would be seen and heard by beach users possibly decreasing their enjoyment of the beach. Vessels and helicopters from State water oil and gas activity would also contribute to beach users' lowered enjoyment, as would commercial and recreational maritime traffic.

The primary impact-producing factors associated with offshore oil and gas exploration and development, and most widely recognized as major threats to the enjoyment and use of recreational beaches, are oil spills, offshore trash, debris, and tar. Additional factors such as the physical presence of platforms and drilling rigs can affect the aesthetics of beach appreciation. Soil contamination and air and water pollution created by the refining of oil and the production of petrochemical products are also of concern.

A study published in the *Journal of Coastal Research* offers some insight into where landings may occur if debris were to fall from an offshore structure. From 1955 to 1987, "surface drifters" (mostly cards and bottles) were intentionally released into GOM waters for study purposes. The authors found that "currents and winds are the dominant factors controlling the geographical distribution of drifter landings." In addition, "the eastern GOM received drifters released primarily in the eastern GOM, whereas western areas received drifters from everywhere." Further, the data revealed that landing distribution was not uniform. Landings were concentrated off Tampa, the Florida Keys, and the eastern seaboard of Florida. Most of the panhandle and western Florida did not receive landings. (Lugo-Fernandez et al., 2001; page 1).

Chapter 4.3.1.1.2., Projections of Spill Incidents, discusses oil spill occurrence. The scenarios analyzed are hypothetical spills occurring from future OCS oil and gas operations in the GOM (**Table 4-15**). The majority of OCS-related coastal spills usually occurs during the transfer of fuel and is likely to originate near terminal locations around marinas, refineries, commercial ports, pipeline routes, and marine terminal areas. The average fuel-oil spill is 18 bbl. It is expected that these frequent, but small spills would not affect coastal beach use.

Although hundreds of small spills are documented annually from all sources within the marine and coastal environment of the Gulf Coast, it is primarily large spills (≥1,000 bbl) that are a major threat to coastal beaches. Should a large spill occur and contact a major recreational beach, regardless of the source, it would result in closures until cleanup is complete (approximately 2-6 weeks). It is expected that short-term displacement of recreational activity from the areas would also occur. Factors such as season, extent of pollution, beach type and location, condition and type of oil washing ashore, tidal action, and cleanup methods would all have a bearing on the severity of effects. Recreational use and tourism would be affected more significantly if spills occurred during peak-use seasons and if publicity were intensive and far-reaching. Sorenson (1990) reviewed the economic effects of several historic major oil spills on beaches and concluded that a spill near a coastal recreation area would reduce visitation in the area by 5-15 percent over one season but would have no long-term effect on tourism.

Summary and Conclusion

Debris and litter derived from both offshore and onshore sources are likely to diminish the tourist potential of beaches and to degrade the ambience of shoreline recreational activities, thereby affecting the enjoyment of recreational beaches throughout the area. Beach trash resulting from a proposed action would be incremental.

Platforms and drilling rigs operating nearshore may affect the ambience of recreational beaches, especially beach wilderness areas. The sound, sight, and wakes of OCS-related and non-OCS-related vessels, helicopters, and other light aircraft traffic, are occasional distractions that are noticed by some beach users.

Oil that contacts the coast may preclude short-term recreational use of one or more Gulf Coast beaches. Displacement of recreational use from impacted areas would occur, and a short-term decline in tourism may result. Beach use at the regional level is unlikely to change from normal patterns; however, closure of specific beaches or parks directly impacted by a large oil spill is likely during cleanup operations.

4.5.14. Impacts on Archaeological Resources

The following cumulative analysis considers the effects of the impact-producing factors related to a proposed action, OCS activities, trawling, sport diving, commercial treasure hunting, seismic exploration in State waters, and tropical storms. Specific types of impact-producing factors considered in this analysis include drilling rig and platform emplacement, pipeline emplacement, anchoring, oil spills, dredging, new onshore facilities, and ferromagnetic debris associated with OCS activities.

4.5.14.1. Historic

Archaeological surveys are assumed to be highly effective in reducing the potential for an interaction between an impact-producing activity and a historic resource, especially in those areas where there is only a thin veneer of unconsolidated Holocene sediments. In those areas that have a thick blanket of unconsolidated Holocene sediments, archaeological surveys are estimated to be 90 percent effective. Archaeological surveys were first required for Lease Sale 32 held in December 1973; therefore, it is assumed that the major impacts to historic resources resulted from development prior to this time. According to estimates presented in **Table 4-4**, 131-244 exploration, delineation, and development wells, and the installation of 5-9 production platforms are projected. Of this range, 98-209 exploration, delineation, and development wells would be drilled at depths between 1,600 and 3,000 m.

Table 4-4 indicates the placement of 1,040-1,664 km of pipelines is projected as a result of the OCS Program in the EPA. While the required archaeological survey minimizes the chances of impacting a historic shipwreck, there remains a possibility that a wreck could be impacted by pipeline emplacement. Such an interaction could result in the loss of or damage to significant or unique historic information.

The setting of anchors for drilling rigs, platforms, and pipeline lay barges, and anchoring associated with oil and gas service-vessel trips to the OCS have the potential to impact historic wrecks. Archaeological surveys serve to minimize the chance of impacting historic wrecks; however, these surveys are not infallible and the chance of an impact from future activities does exist. Impacts from anchoring on a historic shipwreck may have occurred. There is also a potential for future impacts from anchoring on a historic shipwreck. Such an interaction could result in the loss of or damage to significant or unique scientific information.

The probabilities for offshore oil spills ≥1,000 bbl occurring from OCS Program activities are presented in **Chapter 4.3.1.1.2.1.** and **Table 4-15**. Oil spills have the potential to impact coastal historic sites directly or indirectly by physical impacts caused by oil-spill cleanup operations. The impacts caused by oil spills to coastal historic archaeological resources are generally short term and reversible. **Table 4-32** presents the coastal spill scenario from both OCS and non-OCS sources. It is assumed that the majority of the spills would occur around terminals and be contained in the vicinity of the spill. Should such oil spills contact a historic site, the effects would be temporary and reversible.

Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high probability for historic shipwrecks; the greatest concentrations of historic wrecks are likely associated with these features (Garrison et al., 1989). It is reasonable to assume that significant or unique historic archaeological information has been lost as a result of past channel dredging activity. In many areas, the COE requires remote-sensing surveys prior to dredging activities to minimize such impacts.

Past, present, and future OCS oil and gas exploration and development and commercial trawling would result in the deposition of tons of ferromagnetic debris on the seafloor. Modern marine debris associated with these activities would tend to mask the magnetic signatures of historic shipwrecks, particularly in areas that were developed prior to requiring archaeological surveys. Such masking of the signatures characteristic of historic shipwrecks may have resulted or may yet result in OCS activities in the cumulative activity area impacting a shipwreck containing significant or unique historic information.

Trawling activity specifically would only affect the uppermost portions of the sediment column (Garrison et al., 1989). On many wrecks, the uppermost portions would already be disturbed by natural factors and would contain only artifacts of low specific gravity that have lost all original context. **Table 4-7** indicates the projected coastal infrastructure related to OCS Program activities in the cumulative activity area.

Because MMS does not have jurisdiction over pipelines in State waters, the archaeological resource protection requirements of NHPA are not within MMS's jurisdiction. However, other Federal agencies, such as the COE, which issues permits associated with pipelines in State waters, are responsible for the protection of archaeological resources under the NHPA. Therefore, the impacts that might occur to archaeological resources by OCS-related pipeline construction within State waters should be mitigated under the requirements of the NHPA.

Sport diving and commercial treasure hunting are significant factors in the loss of historic data from wreck sites. Efforts to educate sport divers and to foster the protection of historic shipwrecks, such as, those of the Texas Historical Commission and the Southwest Underwater Archaeological Society (Arnold, personal communication, 1997), would serve to lessen these potential impacts. While commercial treasure hunters generally impact wrecks with intrinsic monetary value, sport divers may collect souvenirs from all types of wrecks. Since the extent of these activities is unknown, the impact cannot be quantified. Recently, a Spanish war vessel, *El Cazador*, was discovered in the Central GOM. The vessel contained a large amount of silver coins and has been impacted by treasure hunting salvage operations (*The Times Picayune*, 1993). The historic data available from this wreck and from other wrecks that have been impacted by treasure hunters and sport divers represent a significant or unique loss.

Prior to 1989, explosives (dynamite) were used on the OCS to generate seismic pulses. Small bore drilling rigs were placed on the sea floor to drill to firm or compact sediments before explosive charges were lowered into the bore-hole. Strings of acoustic seismic sensors were also placed on the sea floor to record the seismic profile generated by the explosion. On the OCS as well as in State waters, explosives have been replaced by piston-type acoustic sources that generate superior acoustic signals and that do not cause the damaging environmental impacts associated with explosives. Rapid rise time (high velocity), high peak pressure, and rapid energy decrease characterize acoustical energy from explosives. Seismic air guns are considered non-explosive and have long rise times to peak pressure (low velocity). It is assumed that no explosives would be used in future OCS seismic surveys.

Much of the coast along the northern GOM was hit with 16-20 tropical cyclones between the years 1901 and 1955 (DeWald, 1982). Shipwrecks in shallow waters are exposed to a greatly intensified, longshore current during tropical storms (Clausen and Arnold, 1975). Under such conditions, it is highly likely that artifacts with low specific gravities (e.g., ceramics and glass) would be dispersed. Some of the original information contained in the site would be lost in this process, but a significant amount of information would also remain. Overall, a significant loss of data from historic sites has probably occurred, and will continue to occur, in the northeastern GOM from the effects of tropical storms. Some of the data lost have most likely been significant or unique.

Summary and Conclusion

Several impact-producing factors may threaten historic archaeological resources. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a historic shipwreck located on the continental shelf. The archaeological surveys and resulting archaeological analysis and clearance that are required prior to an operator beginning oil and gas activities on a lease are estimated to be highly effective at identifying possible historic shipwrecks in areas with a high probability and a thick blanket of unconsolidated sediments. OCS development prior to requiring archaeological surveys has possibly impacted wrecks containing significant or unique historic information.

The loss or discard of ferromagnetic debris associated with oil and gas exploration and development and trawling activities could result in the masking of historic shipwrecks.

Loss of significant or unique historic archaeological information from commercial fisheries (trawling) is not expected. It is expected that dredging, sport diving, commercial treasure hunting, and tropical storms have impacted and would continue to impact historic period shipwrecks. Additionally, it is possible that explosive seismic surveys on the OCS and within State waters, prior to 1989, could have impacted historic shipwrecks. Explosive seismic charges set near historic shipwrecks could have displaced the vessel's surrounding sediments acting like a small underwater fault and moving fragile wooden, ceramic and metal remains out of their initial cultural context. Such of an impact would have resulted in the loss of significant or unique archaeological information.

Onshore development as a result of a proposed action could result in the direct physical contact between a historic site and pipeline trenching. It is assumed that archaeological investigations prior to construction would serve to mitigate these potential impacts. The expected effects of oil spills on historic coastal resources are temporary and reversible.

The effects of the various impact-producing factors discussed in this analysis have likely resulted in the loss of significant or unique historic archaeological information. In the case of factors related to OCS Program activities in the cumulative activity area, it is reasonable to assume that most impacts would have occurred prior to 1973 (the date of initial archaeological survey and clearance requirements). The incremental contribution of a proposed lease sale's activities is expected to be very small due to the effectiveness of the required remote-sensing survey and archaeological report. However, there is a possibility of an interaction between bottom-disturbing activity (rig emplacement, pipeline trenching, and anchoring) and a historic shipwreck.

4.5.14.2. Prehistoric

Future OCS exploration and development activities in the EPA within the proposed lease sale area would not impact prehistoric archaeological resources. Water depths in the DeSoto Canyon and Lloyds Ridge Areas range from 1,600 to 3,000 m. Aten (1983) indicates that early man entered the GOM area around 12,000 B.P. According to the relative sea-level curves for the GOM at 12,000 B.P. (CEI, 1977 and 1982), the continental shelf out to the present water depth of about 45-60 m would have been exposed as dry land and available for human habitation. Water depths in the proposed lease sale area range from 1,600 to 3,000 m. Based on the current acceptable seaward extent of the prehistoric archaeological high probability area for this part of the GOM the extreme water depth precludes the existence of any prehistoric archaeological resources within the proposed lease sale area. The placement of 1,040 to 1,664 km of pipelines is projected as a result of the OCS Program in the EPA. While the archaeological survey minimizes the chances of impacting a prehistoric site, there still remains a possibility that a site could be impacted by pipeline emplacement in water depths of <60 m. Such an interaction would result in the loss of significant or unique archaeological information.

The setting of anchors for pipeline lay barges, and anchoring associated with oil and gas service-vessel trips to the OCS have the potential to impact shallowly buried prehistoric sites. Archaeological surveys minimize the chance of impacting these sites; however, these surveys are not seen as infallible and the chance of an impact from future activities exists. Impacts from anchoring on a prehistoric site may have occurred. Such an interaction could result in the loss of significant or unique archaeological information.

The combined probabilities for offshore oil spills ≥1,000 bbl occurring from the OCS Program in the cumulative activity area and contacting the U.S. shoreline are presented in **Chapter 4.3.1.1.2.1.** and **Table 4-15**. Oil spills have the potential to impact coastal prehistoric sites directly or indirectly by physical impacts caused by oil-spill cleanup operations. Coastal, oil-spill scenario numbers are presented in **Table 4-32** for both OCS and non-OCS sources. It is assumed that the majority of the spills would occur around terminals and would be contained in the vicinity of the spill. There is a small possibility of these spills contacting a prehistoric site. Contamination of organic materials in a coastal prehistoric archaeological site by spilled oil can make it difficult or impossible to date the site using Carbon-14 dating techniques. This loss might be ameliorated by using artifact seriation or other relative dating techniques. Coastal prehistoric sites might also suffer direct impact from oil-spill cleanup operations as well as looting resulting from interactions between persons involved in cleanup operations and unrecorded prehistoric sites. Interaction between oil-spill cleanup equipment or personnel and a site could destroy fragile artifacts or disturb site context, possibly resulting in the loss of information on the prehistory of North America and the Gulf Coast region. Some coastal sites may contain significant or unique information.

Most channel dredging occurs at the entrances to bays, harbors, and ports. Bay and river margins have a high probability for the occurrence and preservation of prehistoric sites. Prior channel dredging has disturbed buried and/or inundated prehistoric archaeological sites in the coastal plain of the GOM. It is assumed that some of the sites or site information were unique or significant. In many areas, the COE requires surveys prior to dredging activities to minimize such impacts.

Trawling activity would only affect the uppermost portion of the sediment column (Garrison et al., 1989). This zone would already be disturbed by natural factors, and site context to this depth would presumably be disturbed. Therefore, no effect of trawling on prehistoric sites is assumed.

Table 4-7 indicates the projected coastal infrastructure related to OCS Program activities in the cumulative activity area. Investigations prior to construction in water depths <60 m can determine whether prehistoric archaeological resources occur at these sites.

Because MMS does not have jurisdiction over pipelines in State waters, the archaeological resource protection requirements of the NHPA are not within MMS's jurisdiction. However, other Federal agencies, such as the COE, which lets permits associated with pipelines in State waters, are responsible for the protection of archaeological resources under the NHPA. Therefore, the impacts that might occur to archaeological resources by pipeline construction within State waters should be mitigated under the requirements of the NHPA.

Prior to 1989, explosives (dynamite) were used on the OCS to generate seismic pulses. Explosives have been replaced by piston-type acoustic sources that generate superior acoustic signals and that do not cause the damaging environmental impacts associated with explosives. Rapid a rise time (high velocity), high peak pressure, and rapid energy decrease characterize acoustical energy from explosives. Seismic air guns are considered nonexplosive and have long rise times to peak pressure (low velocity). It is assumed that no explosives would be used in future OCS seismic surveys.

About half of the coast along the northern GOM was hit with 16-20 tropical cyclones between the years 1901 and 1955 (DeWald, 1982). Prehistoric sites in shallow waters and on coastal beaches are exposed to the destructive effects of wave action and scouring currents. Under such conditions, it is highly likely that artifacts would be dispersed and the site context disturbed. Some of the original information contained in the site would be lost in this process. Overall, a significant loss of data from prehistoric sites has probably occurred, and will continue to occur, in the northeastern GOM from the effects of tropical storms.

Summary and Conclusion

Several impact-producing factors may threaten prehistoric archaeological resources of the GOM. An impact could result from a contact between an OCS activity (pipeline, dredging, and anchoring activities) and a prehistoric archaeological site located on the continental shelf at a water depth of <60 m. The required archaeological surveys and resulting archaeological analysis and clearance that are required prior to an operator beginning oil and gas activities in a lease are estimated to be highly effective at identifying possible prehistoric sites. OCS development prior to requiring archaeological surveys has possibly impacted sites containing significant or unique prehistoric information.

The initial dredging of ports and navigation channels and tropical storms are assumed to have caused the loss of significant archaeological information. The likelihood of an oil spill occurring and contacting the coastline is very high. Such contact could result in loss of significant or unique information relating to the dating of a prehistoric site. Onshore development as a result of a proposed action could result in the direct physical contact between a prehistoric site and new facility construction and pipeline trenching. It is assumed that archaeological investigations prior to construction would serve to mitigate these potential impacts.

The shallow depth of sediment disturbance caused by commercial fisheries activities (trawling) is not expected to exceed that portion of the sediments that have been disturbed by wave-generated forces.

The effects of the various impact-producing factors discussed in this analysis have likely resulted in the loss of significant or unique prehistoric archaeological information. In the case of factors related to OCS Program activities in the cumulative activity area, it is reasonable to assume that most impacts would have occurred prior to 1973 (the date of initial archaeological survey and clearance requirements). The incremental contribution of a proposed action's activities is expected to be very small due to the efficacy of the required remote-sensing survey and concomitant archaeological report and clearance.

4.5.15. Impacts on Human Resources and Land Use

The cumulative analysis considers the effects of OCS-related, impact producing as well as non-OCS-related factors. The OCS-related factors consist of prior, current, and future OCS lease sales; non-OCS factors include fluctuations in workforce, net migration, relative income, oil and gas activity in State waters, wetland loss, and tropical storms. Unexpected events that may influence oil and gas activity within the analysis area but cannot be predicted are not considered in this analysis.

4.5.15.1. Land Use and Coastal Infrastructure

Chapters 3.3.5.1.2. and 3.3.5.8. discuss land use and OCS-related oil and gas infrastructure associated with the analysis area. Land use in the analysis area will evolve over time. While the majority of this change is estimated as general regional growth, activities associated with the OCS Program are expected to minimally alter the current land use of the area. Except for 4-16 projected new gas processing plants, the OCS Program would not require any new oil and gas coastal infrastructure. There may be some expansion at current facilities, but the land in the analysis area is sufficient to handle development. There is also sufficient land to construct the projected new gas processing plants in the analysis area.

Shore-based OCS servicing should also increase in the ports of Galveston, Texas, Port Fourchon, Louisiana, and the Mobile, Alabama area due to deepwater activities. There is sufficient land designated in commercial and industrial parks and adjacent to the Galveston and Mobile area ports to minimize disruption to current residential and business use patterns. Port Fourchon, though, has limited land available; they have had to create land on adjacent wetland areas. Any changes in the infrastructure at Port Fourchon that lead to increases in LA Hwy 1 usage, would contribute to the increasing deterioration of the highway. As discussed in **Chapter 3.3.5.2.**, How OCS Development Has affected the Analysis Area, LA Hwy 1 is not able to handle projected OCS activities. In addition, any changes that increase OCS demand of water would further strain Lafourche Parish's water system. In 2003, construction of Edison Chouest's C-Port at Galveston, Texas, to service the WPA and Mexico should be completed and fully operational. This service facility may act to distribute OCS impacts to onshore infrastructure. Similar logic applies to the proposed C-Port in the Mobile area. Other ports in the analysis area plan to make OCS-related infrastructure changes; sufficient land is available at these ports.

Since the State of Florida and many of its residents publicly reject any mineral extraction activities off their coastline, OCS-focused businesses are not expected to locate there.

Summary and Conclusion

Activities relating to the OCS Program are expected to minimally affect the analysis area's land use. Most subareas in the analysis area have strong industrial bases and designated industrial parks to accommodate future growth in OCS-related businesses. Any changes (mostly expansions, except for the 4-16 projected new gas processing plants) are expected to be contained and minimal on available land. Port Fourchon is expected to experience some impacts to its land use from OCS-related expansion. Increased OCS-related usage from port clients is expected to significantly impact LA Hwy 1 in Lafourche Parish. Also, increased demand of water by the OCS would further strain Lafourche Parish's water system.

4.5.15.2. Demographics

This chapter projects how and where future demographic changes would occur and whether they correlate with the OCS Program. The addition of any new human activity, such as oil and gas development resulting from a proposed action, can affect local communities in a variety of ways. Typically, these effects are in the form of people and money that can translate into changes in the local social and economic institutions and land use.

Population

Chapter 3.3.5.4.1. discusses the analysis area's baseline population and projections. Population impacts from the OCS Program, **Tables 4-53 and 4-54** mirror those assumptions associated with employment described below in **Chapter 4.5.15.3.**, Economic Factors. Projected population changes reflect the number of people dependent on income from oil and gas-related employment for their livelihood. This figure is based on the ratio of population to employment in the analysis area over the 40-year analysis period. Activities associated with the OCS Program are expected to have minimal effects on population in most of the coastal subareas. Regions in Louisiana coastal subareas, the Lafourche Parish area in particular, are expected to experience noteworthy increases in population resulting from increases in demand for OCS labor. **Chapter 4.5.15.3.** below discusses this issue in more detail.

Age

The age distribution of the analysis area is expected to remain virtually unchanged with respect to OCS Program activities. Given both the low levels of population growth and industrial expansion associated with the OCS Program, the age distribution pattern discussed in **Chapter 3.3.5.4.2.** is expected to continue throughout the 40-year analysis period.

Race and Ethnic Composition

The racial distribution of the analysis area is expected to remain virtually unchanged with respect to the OCS Program. Given the low levels of employment and population growth and the industrial expansion projected for a proposed action, the racial distribution pattern described in **Chapter 3.3.5.4.3.** is expected to continue throughout the 40-year analysis period.

Education

Activities relating to the OCS Program are not expected to significantly affect the analysis area's educational levels described in **Chapter 3.3.5.4.4.** Some regions in the analysis area, Lafourche Parish in particular, would experience some strain to their education system, but the level of educational attainment would not be affected.

Summary and Conclusion

Activities relating to the OCS Program are expected to minimally affect the analysis area's demography. Baseline patterns and distributions of these factors, as described in **Chapter 3.3.5.4.**, Demographics, are not expected to change for the analysis area as a whole. Some regions within Louisiana coastal subareas, Port Fourchon in particular, are expected to experience some impacts to population and their education system as of a result of increase demand of OCS labor.

4.5.15.3. Economic Factors

This cumulative economic analysis focuses on the potential direct, indirect, and induced impacts of the OCS Program's oil and gas activities in the GOM on the population and employment of the counties and parishes in the analysis area. The regional economic impact assessment methodology used to estimate changes to employment for a proposed lease sale was used for the cumulative analysis.

Tables 4-55 and 4-56 present employment associated with the OCS Program and the percentage to total employment in each coastal subarea. Based on these model results, direct employment associated with OCS Program activities is estimated to range between 55,000 and 74,000 jobs during peak activity years (year 2 through year 11) for the low and high resource estimate scenarios, respectively. There is no clear year of peak impact, employment quickly grows to the peak, stays at relatively high levels from year 2 to year 11, then gradually declines throughout the life of the proposal. Indirect employment is estimated between 21,000 and 28,000 jobs, while induced employment ranges between 25,000 and 33,000 jobs for the same peak period. Therefore, total employment resulting from OCS Program activities is not expected to exceed 101,000-136,000 jobs in any given year over the 40-year impact period.

In Texas, the majority of OCS-related employment is expected to occur in coastal Subarea TX-2, however this employment is only expected to range between 1 and 1.6 percent of the total employment in that coastal subarea. The OCS related employment for all Louisiana coastal subareas is estimated to be substantial. Employment in coastal Subarea LA-1 is projected at 6.3 percent of total employment for the area. This is the most significant impact in Louisiana and in the analysis area as a whole. OCS-related employment for coastal Subareas LA-2 and LA-3 is 3.3 and 3.9 percent of total employment, respectively. The OCS-related employment for the Mississippi and Alabama coastal Subarea, MA-1, is not expected to exceed one percent of the total employment in that area. Model results also reveal there would be little to no economic stimulus to the Florida coastal subareas as a result of OCS Program activities. Population impacts, as conveyed in **Tables 4-53 and 4-54** mirror those assumptions associated with employment.

Employment demand would be met primarily with the existing population and available labor force in most coastal subareas. Some employment would be met through in-migration due to the shadow effect and a labor force lacking requisite skills for the oil and gas and supporting industries. In addition, sociocultural impacts would be minimal in most coastal subareas. Some localized impacts to family life in a small number of cases may result from the offshore work schedule of two weeks on and two weeks off.

On a regional level, the cumulative impact on the population, labor, and employment of the counties and parishes of the impact area is considerable for some focal points. Peak annual changes in the population, labor, and employment of all coastal subareas in the CPA and WPA resulting from the OCS Program are minimal except in Louisiana. On a local level, however, Port Fourchon is currently experiencing full employment, housing shortages, and stresses on local infrastructure—roads (LA Hwy 1), water supply, schools, hospitals, etc. Any additional employment, particularly new residential employment, and the resultant strain on infrastructure, due to the OCS Program, are expected to have a significant impact on the area.

The resource costs of cleaning up an oil-spill, either onshore or offshore, were not included in the above cumulative analysis. The cleanup and remediation of an oil spill involves the expenditure of millions of dollars and the creation of up to hundreds of temporary jobs. While such expenditures are revenues to business and employment/revenues to individuals, spills represent a net cost to society and are a deduction from any comprehensive measure of economic output. In economic terms, spills represent opportunity costs. An oil spill's opportunity cost has two generic components. The first cost is the direct cost to clean up the spill and to remediate the oiled area. This is the value of goods and services that could have been produced with these resources had they gone to production or consumption rather than the cleanup. The second is the value of the opportunities lost or precluded to produce (e.g., harvest oysters) or consume (e.g., recreational/tourism activities) (Pulsipher et al., 1999).

Chapter 4.3.1.1.2., Projections of Spill Incidents, discusses the risk of spill occurrence, the number of spills estimated for the OCS Program, and the likelihood of an OCS-spill contacting the Gulf Coast. The scenarios for the analysis are hypothetical spills of 4,600 bbl and ≥10,000 bbl occurring from future OCS oil and gas operations in the GOM. The magnitude of the impacts discussed below depends on many factors, including the season of spill occurrence and contact, the volume and condition of the oil that reaches shore, the usual use of the shoreline impacted, the diversity of the economic base of the shoreline impacted, and the time required for cleanup and remediation activities. In addition, the extent and type of media coverage of a spill may affect the magnitude and length of time that tourism is reduced to an impacted area.

The immediate social and economic consequences for a region contacted by an oil spill also included non-market effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations. These negative, short-term social and economic consequences of an oil spill are expected to be modest as measured by projected cleanup expenditures and the number of people employed in cleanup and remediation activities.

Negative, long-term economic and social impacts may be more substantial if fishing, shrimping, oystering, and/or tourism were to suffer or were to be perceived as having suffered because of the spill (Pulsipher et al., 1999). **Chapters 4.4.10. and 4.4.12.** contain more discussions of the consequences of a spill on fisheries and recreational beaches.

Summary and Conclusion

The OCS Program would produce only minor economic changes in the Texas, Mississippi, and Alabama coastal subareas. With the exception of TX-2, it is expected to generate a less than 1 percent increase in employment in any of the coastal subareas in these states. Employment associated with the OCS Program only marginally exceeds one percent of total employment for coastal Subarea TX-2. There would be very little economic stimulus in the Florida coastal subareas assuming that the State of Florida remains in opposition to mineral extraction anywhere along its coastline. The OCS Program is projected to substantially impact the Louisiana coastal subareas. The OCS-related employment is expected to peak at 6.3 percent, 3.3 percent, and 3.9 percent of total employment for coastal Subareas LA-1, LA-2, and LA-3, respectively. On a regional level, activities relating to the OCS Program are expected to significantly impact employment in Lafourche Parish in LA-2. Therefore, the population, housing, roads (LA Hwy 1), water supply, schools, and hospitals in the parish would be affected and strained.

The short-term social and economic consequences for the GOM coastal region should a spill ≥1,000 bbl occur includes opportunity costs of 362-1,183 person-years of employment and expenditures of $20.7-67.5 million that could have gone to production or consumption rather than spill-cleanup efforts. Non-market effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations are also expected to occur in the short-term. These negative, short-term social and economic consequences of an oil spill are expected to be modest in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities. Negative, long-term economic and social impacts may be more substantial if fishing, shrimping, oystering, and/or tourism were to suffer or were to be perceived as having suffered because of the spill. Overall employment projected for all OCS oil and gas activities, including employment in the oil-spill response industry, is projected to be substantial (up to 6.3% of baseline employment in some subareas).

4.5.15.4. Environmental Justice

This analysis addresses routine operations over time and how they could affect environmental justice. These operations center on onshore activity such as employment, migration, commuter traffic, and truck traffic, and on the infrastructure supporting this activity, including fabrication yards, supply ports, and onshore disposal sites for offshore waste. Due to the widespread presence of an extensive OCS support system and an associated labor force effects of a proposed action or the OCS Program would be widely yet thinly distributed across the study area and would consist of slightly increased employment and an even slighter increase in population. Cumulative employment would increase less than one percent in

Mississippi and Alabama and slightly more than one percent from Houston/Galveston east to the state line. In Louisiana, employment impacts would be more substantial, ranging from 3.9 to 6.3 percent. Some places could experience elevated employment, population, infrastructure, and/or traffic effects because of local concentrations of fabrication and supply operations. For example, Lafourche Parish, Louisiana, has high concentrations of industry activity. Increased employment here would likely strain local infrastructure.

Environmental justice involves the potential for disproportionate and negative effects on minority and low-income populations. Cumulative employment opportunities would increase slightly in a wide range of businesses over the entire planning area. These conditions preclude a prediction of where much of this employment would occur or who would be hired. **Figures 3-14 and 3-15** provide distributions of census tracts of high concentrations of minority and low-income households. As stated in **Chapter 3.3.5.10.**, Environmental Justice, there are pockets of such populations scattered throughout coastal counties and parishes along the GOM. Most live in large urban areas where the complexity and dynamism of the economy and labor force preclude a measurable effect. The exception is the oyster tongers and seafood processors in and around Apalachicola Bay. Because the distribution of low-income and minority populations does not reflect the distribution of industry activity, cumulative effects are not expected to be disproportionate.

Cumulative economic effects on minority and low-income populations are expected to be neutral. Research sponsored by MMS has gathered information on race and employment. This research has revealed that offshore workers in the production sector are almost entirely male and white (Rosenberg, personal communication, 2001). However, other sectors, such as the fabrication industry and support industries do employ minority workers and provide jobs across a range of pay levels and educational/skill requirements (Austin et al., 2002a and b; Donato 1998). A study of oil industry trends between 1980 and 1990 found that downsizing was concentrated in the production sector. Hence, it affected white male employment more than that of women or minorities (Singelmann, in press). Evidence also suggests that a healthy offshore petroleum industry indirectly benefits low-income and minority populations. One Louisiana study found that income inequality decreased during the oil boom and increased with the decline (Tolbert, 1995). Another study found that in one rural town, after being laid off due to a plant closing, the re-employment rates for poorly educated black and white women were much higher than rates in similar closings elsewhere. This was because Louisiana's oil industry had created a complex local economy (Tobin, 2001). Except in Louisiana, the cumulative case is expected to provide little additional employment. This addition, along with the effect of maintaining current activity levels, is expected to be beneficial to low-income and minority populations.

The siting of infrastructure is often an environmental justice concern since it may have disproportionate and negative effects on minority and low-income populations. While no one lease sale would generate significant new infrastructure, new pipeline landfalls (23-38), pipeline shore facilities 12-20), and gas processing plants (4-16) are projected over the next 40 years (**Table 4-7**). At present, there are 126 OCS pipeline landfalls, 50 pipeline shore facilities, and 35 gas processing plants in the GOM region. Because of existing capacity, no new waste disposal sites are projected (Louis Berger Group, in preparation). As discussed in the environmental justice analysis of oil spills (**Chapter 4.4.14.4.**), existing coastal populations are not generally minority or low-income. This is true from Jefferson County, Texas, to Franklin County, Florida. While several census tracts around Morgan City and in the lower Mississippi River delta area have 50 percent or greater minority populations (**Figure 3-14**), the coastal areas of these tracts, like most of coastal Louisiana, has little to no human settlement. In Mississippi, coastal areas are either devoted to commerce (casinos and hotels) or heavy industry. In Alabama, higher income people and tourists populate the coasts of both counties. The same is true for most of Florida's Panhandle.

Projected pipeline landfalls and shore facilities mirror the current distribution of such facilities. Their location and activities would not disproportionately affect minority or low-income populations. Projected gas processing plants reflect the location of offshore reserves, available capacity in existing facilities, and onshore demand. The projected distribution is based on economic and logistical considerations unrelated to the distribution of minority or low-income populations and would not disproportionately affect these populations.

Each OCS-related facility that may be constructed onshore must receive approval by the relevant Federal, State, county or parish, and involved communities. Each onshore pipeline must obtain similar permit approval and concurrence. The MMS assumes that any construction would be approved only if it is consistent with appropriate land-use plans, zoning regulations, and other State/regional/local regulatory mechanisms. Should a conflict occur, MMS assumes that approval would not be granted or that appropriate mitigating measures would be enforced by the appropriate political entities.

Chapter 3.3.5., Human Resources and Land Use, describes Louisiana's extensive oil-related support system. Analysis in **Chapter 4.2.1.15.3.**, Economic Factors, shows that Louisiana has in the past and would continue to experience more employment effects than the other Gulf Coast States. Furthermore, Lafourche Parish, Louisiana, is expected to experience the greatest concentration of effects. These effects may be significant enough to affect and strain the local infrastructure. The concentrated socioeconomic impacts in Lafourche Parish are not expected to have disproportionate effects on minority and low-income populations for several reasons. The parish is not predominately low-income or minority (**Figures 3-14 and 3-15**). The Houma, a Native American tribe recognized by the State of Louisiana, has been identified by MMS as a minority group potentially affected by OCS-related activities. MMS is funding a study focused on Lafourche Parish, the Houma, and other possible concerns. Existing information indicates that the Houma would not be disproportionately affected because they are not residentially segregated but, rather, live interspersed among the non-minority population (Fischer, 1970).

Two infrastructure issues in Lafourche Parish (the traffic on LA Hwy 1 and the expansion of Port Fourchon) could possibly have related environmental justice concerns. The most serious concern, raised during public scoping meetings, is increased truck traffic on LA Hwy 1. The traffic, destined for Port Fourchon, physically stresses the highway, inconveniences and sometimes disrupts local communities, and may pose health risks in the form of increased accident rates and possible interference to hurricane evacuations (Keithly, 2001; Hughes, 2002). However, the area's "string settlement pattern" means that rich and low-income alike live on a narrow band of high ground along LA Hwy 1 and would be equally affected by increased traffic.

Port Fourchon, as it exists today, is a relatively new facility. It is mostly surrounded by uninhabited wetlands. Residential areas close to the port are new and not low-income. While the minority and low-income populations of Lafourche Parish would share with the rest of the population the cumulative negative impacts of the OCS Program, most effects are expected to be economic and positive. The link between a healthy oil industry and indirect economic benefits to all sectors of society may be weak in some parts of the GOM region, but it is strong in Lafourche Parish. The Parish is part of an area of relatively low unemployment due to the concentration of petroleum industry activity (Hughes, in press).

Many studies of social change in the GOM region suggest that the offshore petroleum industry, and even the near-shore and onshore petroleum industry, have not been a critical factor except in small areas for limited periods of time. This was a key conclusion of an MMS-funded study of the historical role of the industry in the GOM, a study that addressed social issues related to environmental justice (Wallace, 2001). The MMS 5-Year Programmatic EIS (USDOI, MMS, 2001b) notes that the characterization of the GOM's sociocultural systems suggests that the historical impacts of offshore oil and gas activities on the sociocultural environment have not been sweeping, but varied from one coastal community to the next. While regional impacts may be unnoticed or very limited, individual communities may or may not realize adverse sociocultural impacts. Further, non-OCS activities also have the potential for sociocultural impacts. These activities can lead to changes in social organization by being a catalyst for such things as in-migration, demographic shifts, population change, job creation and cessation, community development strategies, and overall changes in social institutions (family, government, politics, education, and religion). The MMS 5-Year programmatic analysis concludes that non-OCS activities have made, and would make, substantially larger contributions to the environmental justice effects than the OCS Program.

Summary and Conclusion

The cumulative effects of the OCS program are expected to be widely distributed and limited in magnitude due to the presence of an extensive and widespread support system and associated labor force. Most cumulative effects are expected to be economic and have a limited but positive effect on low-income and minority populations. In Louisiana these positive economic effects are expected to be greater. In general, who would be hired and where new infrastructure might be located is impossible to predict. Given the existing distribution of the industry and the limited concentrations of minority and low-income peoples, the cumulative case would not have a disproportionate effect on these populations. Lafourche Parish would experience the most concentrated and cumulative effects of the study area.

Because the parish is not heavily low-income or minority and road traffic and port expansion would not occur in areas of low-income or minority concentration, these groups are not expected to be differentially affected.

A proposed action is not expected to have disproportionately high/adverse environmental or health effects on minority or low-income people. In the study area, the contribution of a proposed action and the OCS program to all actions and trends affecting environmental justice over the next 40 years is expected to be negligible to minor.

4.6. Unavoidable Adverse Impacts of the Proposed Actions

Unavoidable adverse impacts associated with a proposed action are expected to be primarily short-term and localized in nature and are summarized below.

Sensitive Coastal Habitats: If an oil spill were to contact a barrier beach, the removal of beach sand during cleanup activities could result in adverse impacts if the sand is not replaced. If an oil spill contacts coastal wetlands, adverse impacts could be high in localized areas. In some areas, wetland vegetation would experience suppressed productivity for several years. Much of the wetland vegetation would recover over time, but some wetland areas would be converted to open water. Unavoidable impacts resulting from maintenance dredging, wake erosion, and other secondary impacts related to channels would occur as a result of the proposed actions.

Sensitive Offshore Habitats: If an oil spill occurred and contacted sensitive offshore habitats, there could be some adverse impacts on organisms contacted by oil.

Water Quality: Routine offshore operations would cause some unavoidable effects to varying degrees on the quality of the surrounding water. Drilling, construction, and pipelaying activities would cause an increase in the turbidity of the affected waters for the duration of the activity periods. A turbidity plume would also be created by the discharge of drill cuttings and drilling fluids. This, however, would only affect water in the immediate vicinity of the rigs and platforms. The discharge of treated sewage from the rigs and platforms would increase the levels of suspended solids, nutrients, chlorine, and BOD in a small area near the discharge point for a short period of time. Accidental spills from platforms and the discharge of produced waters could result in increases of hydrocarbon levels and trace metal concentrations in the water column in the vicinity of the platforms.

Unavoidable impacts to onshore water quality would occur as a result of chronic point- and nonpoint-source discharges such as runoff and effluent discharges from existing onshore infrastructure used in support of lease sale activities. Vessel traffic contributes to the degradation of impacted bodies of water through inputs of chronic oil leakage, treated sanitary and domestic waste, bilge water, and contaminants known to exist in ship paints. Regulatory requirements of the State and Federal water authorities and some local jurisdictions would be applicable to point-source discharges from support facilities such as refineries and marine terminals.

Air Quality: Unavoidable short-term impacts to air quality could occur near catastrophic events (e.g., oil spills and blowouts) due to evaporation and combustion. Mitigation of long-term effects would be accomplished through existing regulations and development of new control emission technology. However, short-term effects from nonroutine catastrophic events (accidents) are uncontrollable.

Endangered and Threatened Species: Unavoidable adverse impacts to endangered and threatened marine mammals, birds, sea turtles, mice, and the Gulf sturgeon due to activities associated with a proposed action (e.g., water quality and habitat degradation, helicopter and vessel traffic, oil spills and spill response, and discarded trash and debris) would be primarily sublethal. Lethal impacts to endangered species are expected to be rare.

Nonendangered and Nonthreatened Marine Mammals: Unavoidable adverse impacts to nonendangered and nonthreatened marine mammals due to activities associated with a proposed action (e.g., water quality degradation, helicopter and vessel traffic, oil spills and spill response, and discarded trash and debris) would be primarily sublethal. Lethal impacts to nonendangered and nonthreatened marine mammals are expected to be rare.

Coastal and Marine Birds: Some injury or mortality to coastal birds could result in localized areas from OCS-related oil spills, helicopter and OCS service-vessel traffic, and discarded trash and debris. Marine birds could be affected by noise, disturbances, and trash and debris associated with offshore activities. If an oil spill occurs and contacts marine or coastal bird habitats, some birds could experience sublethal impacts and birds feeding or resting in the water could be coated with oil and die. Oil spills and oil-spill cleanup activities could also affect local bird prey species.

Fish Resources and Commercial Fisheries: Losses to fishing resources and fishing gear could occur from production platform placement, oil spills, and produced-water discharges. Localized populations of fish species are expected to experience sublethal effects. This could result in a temporary decrease in a local population on a local scale. It is unlikely that fishermen would harvest fish in the area of an oil spill, as spilled oil could coat or contaminate commercial fish species rendering them unmarketable. Other unavoidable adverse impacts include loss of fishing space caused by the installation of pipelines, rigs, platforms, or by other OCS-related structures.

Recreational Beaches: Even though existing regulations prohibit littering of the marine environment with trash, offshore oil and gas operations may result in the accidental loss of some floatable debris in the ocean environment; this debris may eventually come ashore on major recreational beaches. Accidental events can lead to oil spills, which are difficult to contain in the ocean; therefore, it may be unavoidable that some recreational beaches become temporarily soiled by weathered crude oil.

Archaeological Resources: As a result of the proposed actions, unique or significant archaeological information may be lost. Required archaeological surveys significantly reduce the potential for this loss by identifying potential archaeological sites prior to an interaction occurring, thereby making avoidance or mitigation of impacts possible. In some cases (e.g., in areas of high sedimentation rates), survey techniques may not be effective at identifying a potential resource.

4.7. Irreversible and Irretrievable Commitment of Resources

Irreversible or irretrievable commitments of resources refer to impacts or losses to resources that cannot be reversed or recovered. Examples are when a species becomes extinct or when wetlands are permanently converted to open water. In either case, the loss is permanent.

Wetlands: An irreversible or loss of wetlands and associated biological resources could occur if wetlands are permanently lost due to impacts from dredging, construction activities, or oil spills. Dredging activities can result in direct and indirect loss of wetlands, and oil spills can damage or destroy wetland vegetation, which leads to increased erosion and conversion of wetlands to open water.

Sensitive Offshore Resources: Oil spills and chronic low-level pollution can injure and kill organisms at virtually all trophic levels. Mortality of individual organisms can be expected to occur, and possibly a reduction or even elimination of a few small or isolated populations. The proposed biological stipulations, however, are expected to eliminate most of these risks.

Fish Resources and Commercial Fisheries: In view of the positive impact of offshore platforms to fish resources and commercial fishing as a result of the platforms serving as artificial reefs and fish attracting devices, continued structure removal, regardless of the technique used, would reduce the net benefits to commercial fishing due to the presence of these structures.

Recreational Beaches: Beached litter, debris, oil slicks, and tarballs may result in decreased enjoyment or lost opportunities for enjoyment of coastal recreational resources.

Archaeological Resources: Although the impact to archaeological resources as a result of a proposed action is expected to be low, any interaction between an impact-producing factor (drilling of wells, emplacement of platforms, subsea completions, and pipeline installation) and a significant historic shipwreck or prehistoric site could destroy information contained in the site components and in their spatial distribution. This would be an irretrievable commitment of potentially unique archaeological data.

Oil and Gas Development: Leasing and subsequent development and extraction of hydrocarbons as a result of the proposed actions could represent an irreversible and irretrievable commitment of nonrenewable oil and gas resources. The estimated amount of resources to be recovered as a result of a proposed action is presented in **Table 4-1**.

Loss of Human and Animal Life: The OCS oil and gas exploration, development, production, and transportation are carried out under comprehensive, state-of-the-art, enforced regulatory procedures designed to ensure public safety and environmental protection. Nonetheless, some loss of human and animal life is inevitable from unpredictable and unexpected acts of man and nature (unavoidable accidents, human error and noncompliance, and adverse weather conditions). Some normal and required operations, such as structure removal, can result in the destruction of marine life. Although the possibility exists that individual marine mammals, marine turtles, birds, and fish can be injured or killed, there is unlikely to be a lasting effect on baseline populations.

4.8. Relationship Between the Short-term Use of Man's Environment and the Maintenance and Enhancement of Long-term Productivity

In this section, the short-term effects and uses of various components of the environment in the vicinity of proposed actions are related to long-term effects and the maintenance and enhancement of long-term productivity.

Short-term refers to the total duration of oil and gas exploration and production activities, whereas long-term refers to an indefinite period beyond the termination of oil and gas production. The specific impacts of a proposed action vary in kind, intensity, and duration according to the activities occurring at any given time. Initial activities, such as seismic surveying and exploration drilling, result in short-term, localized impacts. Development drilling and well workovers occur sporadically throughout the life of a proposed action, but also result in short-term, localized impacts. Activities during the production life of a platform may result in chronic impacts over a longer period of time (over 30 years), potentially punctuated by more severe impacts as a result of accidental events. Platform removal is also a short-term activity with localized impacts; the impacts of site clearance may be longer lasting. Over the long-term, several decades to several hundreds of years, natural environmental balances are expected to be restored.

Many of the effects discussed in **Chapter 4.2.1.**, Alternative A – The Proposed Actions, are considered to be short-term (being greatest during the construction, exploration, and early production phases). These impacts could be further reduced by the mitigation measures discussed in **Chapter 2.**

The principle short-term use of the leased areas in the GOM would be for the production of 0.065-0.085 BBO and 0.265-0.340 Tcf of gas from a typical proposed action. The short-term recovery of hydrocarbons may have long-term impacts on biologically sensitive offshore areas or archaeological resources.

The OCS activities could temporarily interfere with recreation and tourism in the region, in the event of an oil spill contacting popular tourist beaches. The proposed leasing may also result in onshore development and population increases that could cause very short-term adverse impacts to local community infrastructure, particularly in areas of low population and minimal existing industrial infrastructure (**Chapter 4.2.1.15.**, Impacts on Human Resources and Land Use). A return to equilibrium could be quickly expected as population changes and industrial development are absorbed in expanded communities. After the completion of oil and gas production, the marine environment is generally expected to remain at or return to its normal long-term productivity levels. To date, there has been no discernible decrease in long-term marine productivity in OCS areas where oil and gas have been produced for many years. Areas such as the Atlantic Coast, which experienced repeated incidents of oil pollution as a result of tanker groundings during World War II, show no apparent long-term productivity losses, although baseline data do not exist to verify this. In other areas that have experienced apparent increases in oil pollution, such as the North Sea, some long-term effects do appear to have taken place. Populations of pelagic birds have decreased markedly in the North Sea in recent years—prior to the beginning of North Sea oil production. Until more reliable data become available, the long-term effects of the chronic and major spillage of hydrocarbons and other drilling-related discharges cannot be accurately projected. In the absence of such data, it must be concluded that the possibility of decreased long-term productivity exists as a result of the proposed actions.

The OCS development off Louisiana and Texas has enhanced recreational and commercial fishing activities, which in turn has stimulated the manufacture and sale of larger private fishing vessels and special fish recreational equipment. Commercial enterprises such as charter boats have become heavily dependent on offshore structures for satisfying recreational customers. The proposed actions could increase these incidental benefits of offshore development. Offshore fishing and diving has gradually increased in the past three decades; platforms have been the focus of much of that activity. As mineral resources become depleted, platform removals would occur and may result in a decline in these activities. To maintain the long-term productivity of site-specific, artificial reefs attractive to fishermen and divers may need to eventually replace removed platforms.

Short-term environmental socioeconomic impacts could result from the proposed actions, including possible short-term losses in productivity as a result of oil spills. Long-term adverse environmental impacts would not be expected because archaeological regulations and the proposed biological stipulations are proposed as part of the proposed actions. However, some risk of long-term adverse environmental impacts remains due to the potential for accidents. No long-term productivity or environmental gains are expected as a result of the proposed actions; the benefits of the proposed actions are expected to be primarily those associated with a medium-term increase in supplies of domestic oil and gas. While no reliable data exist to indicate long-term productivity losses as a result of OCS development, such losses are possible.