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.

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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