OCS EIS/EA
MMS 2002-006

Outer Continental Shelf Oil & Gas Leasing Program: 2002-2007

Final Environmental Impact Statement
April 2002

Volume I

U.S. Department of the Interior
Minerals Management Service

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PROPOSED OUTER CONTINENTAL SHELF
OIL & GAS LEASING PROGRAM: 2002-2007
ENVIRONMENTAL IMPACT STATEMENT

Draft ( ) **Final (X)**

Type of Action: **Administrative (X)** **Legislative ( )**

Areas of Potential Impact: Offshore marine environment and coastal counties of Alabama, Alaska, California, Florida, Louisiana, Mississippi, Oregon, Texas, and Washington.

Responsible Agency: U.S. Department of the Interior
Minerals Management Service
381 Elden Street
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Abstract:

This environmental impact statement analyzes the effects of the adoption of a schedule of lease sales indicating, as precisely as possible, the size, timing, and location of leasing activities, consistent with the requirements of Section 18 of the Outer Continental Shelf (OCS) Lands Act, 43 U.S.C. §1344, for the period of mid-2002 through mid-2007. The proposed action is a plan to offer areas of the Federal OCS for lease for oil and natural gas exploration and development. This document analyzes the potential consequences of a 5-year leasing program which would schedule 20 sales in 8 of the 26 OCS planning areas. Three alternatives which would modify this schedule of sales, and one alternative which would schedule no sales, have also been analyzed.

Hypothetical scenarios were developed indicating the level of routine exploration and development activities and accidental events (such as oil spills) which might result if the plan is adopted and areas are actually leased and explored, and economically recoverable resources were discovered and produced. The impacts to the environmental resources represent the aggregation of all the potential changes which might result from these routine activities or accidental events.

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SUMMARY

The Proposal

The U.S. Department of the Interior (USDOI) proposes 20 lease sales in eight of the Outer Continental Shelf (OCS) planning areas in the Gulf of Mexico and offshore Alaska during the period 2002-2007. Five sales each would be held annually in the Central and Western Gulf of Mexico Planning Areas, and two sales would be held in the Eastern Gulf of Mexico Planning Area. The following sales would be held in the Alaska Region: three sales in the Beaufort Sea Planning Area, two sales in the Chukchi Sea and Hope Basin Planning Areas (combined), two sales in the Cook Inlet Planning Area, and one sale in the Norton Basin Planning Area. No lease sales are proposed on the U.S. east or west coasts. A decision to adopt the program proposal is not a decision to issue specific leases or to authorize any drilling or development. Rather, the proposed program establishes a schedule that the USDOI will use as a basis for considering where and when leasing might be appropriate over a 5-year period. We propose to offer for lease all unleased blocks for each sale in the Western and Central Gulf of Mexico. However, in the Eastern Gulf of Mexico and the five planning areas in Alaska, we propose leasing in only a small portion of the planning area. Alternatives to the proposal are summarized below.

Activities that could occur on leases issued as a result of sales on the proposed leasing may extend over a period of 25 to 40 years. Among the types of activities analyzed for environmental impacts are: (1) drilling oil and natural gas exploration and production wells; (2) installing and operating offshore platforms and pipelines, and onshore support facilities; and (3) transporting oil using ships or pipelines. The specific amounts and locations of activity that might occur as a result of adopting the proposal or an alternative are unknown. The environmental analysis is based on reasoned assumptions about future activities. The assumptions constitute a scenario of activities developed for the proposal and each alternative. Estimates of oil and gas resources that might be found in and produced from the areas being considered for leasing provide the basis for making the assumptions. Each scenario contains the major elements of activity needed to support exploration, production, and transportation of oil and gas that may be discovered and found to be economically producible.

Alternatives

Four alternatives to the proposed action (alternative 1) are evaluated in this environmental impact statement (EIS). Each alternative represents a variation of the proposal with respect to size, timing, and location of possible future lease offerings. The proposed action is the USDOI's preferred alternative.

- **Slow the Pace of Leasing (alternative 2)**. Only one or two sales would be held in the Beaufort Sea Planning Area. One sale rather than two would be held in the Chukchi Sea and Hope Basin (combined), the Eastern Gulf of Mexico, and Cook Inlet Planning Areas. Leasing in other planning areas would be the same as alternative 1.
- **Exclude Some Planning Areas (alternative 3)**. No sales would be conducted in the Eastern Gulf of Mexico and Norton Basin Planning Areas, and the Chukchi Sea sale would not include any blocks in the Hope Basin Planning Area. Leasing in other planning areas would be the same as alternative 1.
- **Accelerated Leasing (alternative 4)**. Lease sales would be held annually in the Beaufort Sea Planning Area, and three sales would be held in the Eastern Gulf of Mexico Planning Area. The

size and location of the blocks offered would be the same as alternative 1. Leasing in other planning areas would be the same as alternative 1.

- **No Action (alternative 5)**. No lease sales would be conducted in any OCS planning areas during the period 2002-2007. Exploration, development, and production activities would continue on blocks leased previously.

Principal Issues And Concerns

Risks of Oil Spills: Major advancements in drilling and production technology have been made in recent years reducing the risk of oil spills from OCS operations. Nevertheless, concerns remain that OCS oil spills will occur and result in unacceptable impacts on the environment. We cannot predict with certainty whether oil spills will occur, where they may occur, or how severe they may be. For purposes of analysis, we calculated the risk of oil-spill occurrence for the proposal using historical oil-spill data and estimates of the oil resources that might be produced from each planning area under the proposal. That risk varies from region to region and is proportional to the amount of oil that could be produced and transported.

Although the likelihood of oil-spill occurrence can be estimated using oil production estimates and observed spill rates, predicting the degree to which a particular environmental resource would be affected by spilled oil requires a knowledge of where, when, and under what environmental conditions spills might occur. The potential consequences of an oil spill depend on many variable circumstances that are unpredictable. However, if a large oil spill were to occur and contact sensitive resources, significant impacts could result. An understanding of these potential impacts is an important consideration when decisions are made about OCS oil activities. Therefore, we have analyzed in the EIS the effects of oil spills assuming some spills will occur and contact sensitive resources. While this analysis provides the Secretary of the USDOI with information about the potential impacts if spills were to occur and contact environmental resources, we are not predicting whether, when, or where specific oil spills will occur or whether they will contact environmental resources. As noted above, the EIS does provide information on the likelihood of spill occurrence based on historical oil-spill data, which is independent from the severity of oil spill impacts.

Effects of Noise: There has been increasing concern in recent years within the scientific community about the potential adverse effects of noise on marine resources, in particular, marine mammals and sea turtles. Seismic surveys, drilling and production activities at offshore facilities, and support vessel traffic generate noise that could affect these marine resources. Therefore, we included in the EIS analyses of potential physical and behavioral effects on marine mammals and sea turtles.

Subsistence Activities and Resources in Alaska: Subsistence activities are extremely important in all parts of rural Alaska and, combined with kinship, comprise the fundamental characteristic for describing Native (and some non-Native) social organization and culture. Diverse subsistence activities take place in all Alaska coastal regions potentially affected by the proposed action. Fish and marine mammals are the resources of most concern, as they constitute a large part of the harvest and typically are the resources most likely to be directly affected by OCS activities. Waterfowl and land mammals are also important subsistence resources, although the later are potentially affected primarily by transportation pipelines and other support infrastructure and services. For most Alaska Natives, if not all, subsistence (and the relationship between people, on the one hand, and the land and water and its resources, on the other) is the characteristic of cultural identity. Therefore, an analysis of subsistence, the most dominant nonmonetary economic activity in rural Alaska, is included in the EIS.

Sensitive Biological Resources and Critical Habitats: The geographic scope of the proposed program is significantly smaller than OCS oil and gas programs ten and twenty years ago. However, the proposed program still encompasses large areas in the Gulf of Mexico and portions of offshore Alaska, and these areas constitute diverse marine and coastal environments. At this programmatic stage, it is not possible, or appropriate, to conduct site-specific analyses of all the potentially affected resources. Therefore, in keeping with the National Environmental Policy Act regulations, the EIS focuses on issues of most concern and those aspects of marine resources that are unique or most susceptible to impacts from offshore oil and gas activities. For example, threatened and endangered species are given special attention, and the EIS emphasizes vulnerable seafloor resources. The EIS also concentrates on those life stages and habitats that are most sensitive to the impact-cause factors of the proposed program, such as oil spills and the emplacement of structures on the seafloor.

Principal Conclusions

The analyses in this EIS describe in detail the nature and extent of potential impacts of the proposal and alternatives. One objective of the EIS is to concisely convey to decisionmakers and the public the relative extent of potential impacts. For that reason, we present conclusions for most analyses that generally indicate the ability of an affected resource to recover from impacts that could result from the proposed action. This summary discusses issues of primary concern and the potentially most extensive impacts.

The analyses reach conclusions that indicate one of four levels of impact: negligible, minor, moderate, and major. These impact levels are defined in Section 4.2. Separate conclusions are given for routine OCS operations and oil spills. As noted above, the analyses and conclusions for oil spills assume one or more spills occur and contact the resource of concern.

The Gulf of Mexico Region

Two marine mammal species of particular concern in the Gulf are the endangered sperm whale and West Indian manatee. The sperm whale is the only common endangered whale in the Gulf. The West Indian manatee is a coastal species that is usually found in the coastal and inshore waters of peninsular Florida, well away from most offshore OCS activities. Impacts from routine operations would be minor for sperm whales and negligible for the West Indian manatee. If a large oil spill were to occur and contact sperm whales or manatees, impacts could be minor for the sperm whale and minor to moderate for the West Indian manatee.

Most sea turtles in the Gulf of Mexico are distributed within waters of the continental shelf. If a large spill were to occur nearshore during the spring and summer nesting season, it is probable that some individuals or sea turtle nesting beaches would be contacted by oil. Leatherbacks and some loggerheads are also regularly sighted within deepwater areas over the continental slope. In addition, juvenile turtles are regularly found within convergence zones in deepwater areas. Although the relative numbers of turtles within the deepwater Gulf of Mexico are relatively small when compared to the continental shelf, it is possible that individuals may be affected if a large spill were to occur in deep water. It is possible that some individuals may not recover from such exposure. However, the viability of sea turtle populations as a whole would not be threatened. Overall, if oil spills were to occur and contact sea turtles or nesting beaches, the impacts would be moderate.

Certain species of marine and coastal birds may be more susceptible to contact with spilled oil than others, based upon their life histories. For example, diving birds and underwater swimmers such as loons, cormorants, and diving ducks may be particularly susceptible to spilled oil because of their relative exposure time within the water and at the sea surface. At the same time, if a large pipeline spill were to occur nearshore, relatively large numbers of marine and coastal birds could be contacted by spilled oil if it reached coastal habitats with high bird abundance before being contained or cleaned up. In such a case, bird mortality could range in the hundreds of individuals, and impacts overall could be moderate.

If a large oil spill were to occur in shallow water and reaches coastal wetlands in any of the Gulf of Mexico planning areas, there is a reasonable possibility these resources may not fully recover even if remedial action is taken. Impacts would be minor to moderate because the overall viability of the wetland resource would not be threatened. If an oil spill were to reach seagrass beds, it would be difficult to clean up the oil, which is likely to persist in fine sediments and vegetation. Some areas may recover completely if proper remedial action were taken. Others may not recover completely, but overall the viability of the resource would not be threatened. Impacts would be minor to moderate.

The proposed program is predicted to have no more than minor effects on the Flower Garden Banks National Marine Sanctuary and should not affect the Florida Keys National Marine Sanctuary because no proposed leasing is remotely near the Florida Keys. Moderate impacts could occur to a park, refuge, or reserve if a large spill were to occur near the coast and contacted one of these designated special areas.

Only minor impacts to tourism and recreation in the Gulf of Mexico are predicted, although if a large oil spill were to occur and contact beaches during the peak of the beach recreation season, impacts could be moderate.

If one sale was held in the Eastern Gulf of Mexico Planning Area rather than two (alternative 2), there would be a corresponding reduction in the level of exploration, development, and production activity. As a result, the impacts to some resources in the Eastern Gulf will be somewhat less than the impacts of the proposal. For example, less bottom will be disturbed because fewer platforms and pipelines will be put in place. Fish that feed on benthic organisms will benefit because there will be less sedimentation and smothering of benthic organisms. The decrease in noise and turbidity levels could cause less displacement of fish from their normal habitat. Impacts on population, employment, and regional income will be slightly less. There will also be fewer space-use conflicts between the oil and gas industry and commercial fisheries. Even though there is somewhat less impact for these resources at the local level in the Eastern Gulf, if alternative 2 is adopted, the level of oil and gas activity in the Central and Western Gulf of Mexico will be the same as the proposal. Therefore, the overall impact levels for alternative 2 will be the same as the proposal.

If no sales were held in the Eastern Gulf of Mexico between 2002 and 2007 (alternative 3), some impacts could still occur in the Eastern Gulf due to oil and gas activities in the Central Gulf of Mexico Planning Area. However, impacts to coastal resources in Florida are much less likely because of the distance from any offshore activities from the proposed program. For example, the predicted impacts to the West Indian Manatee, which is distributed primarily along the Florida coast, would be negligible. Live bottom areas are located primarily on the continental shelf offshore west Florida, and most of the seagrass beds in the Gulf of Mexico are located off the coast of Florida. If alternative 3 is adopted, the primary threat to these resources from oil and gas activities and potential spills in the Eastern Gulf would be eliminated, and the overall impact level is predicted to be negligible. Because the program area in the Eastern Gulf for the proposal is 100 miles or more from the Florida coast and at the western extreme of the Eastern Gulf of Mexico Planning Area, if alternative 3 is adopted, there would be no measurable difference in impacts to tourism and recreation in Florida; to parks, refuges, and reserves along the west coast of Florida; or to the Florida Keys National Marine Sanctuary.

If three sales rather than two were held in the Eastern Gulf of Mexico Planning Area (alternative 4), there would be a corresponding increase in the level of exploration, development, and production activity in the Eastern Gulf and support facilities in the Central Gulf. The same number of sales would be conducted in the Eastern and Western Gulf of Mexico Planning Areas, resulting in the same types and levels of oil and gas activities assumed for the proposal. Based on the slight differences in levels of activity in the Eastern Gulf estimated at this programmatic stage, impact levels cannot be differentiated for any potentially affected resources, either at the local or regional level. Overall, if the same number of sales were conducted in the Central and Western Gulf of Mexico but one additional sale was held in the Eastern Gulf, it is expected that the overall impact levels for all affected resources would be the same as those predicted for the proposed action.

The Alaska Region

The main impact factor associated with the routine operations of the proposed action that may affect cetaceans in Alaska is noise associated with prelease and postlease surveys, drilling and production, and decommissioning and abandonment activities. Impacts to cetaceans from the proposed action range from negligible to moderate depending on the species. Overall, noise from OCS operations, when forcing an alteration of migratory pathways, would produce minor impacts to bowhead whale populations. Since the population of Cook Inlet beluga whales is at a low level and in decline, disturbances, which could reduce fitness, could have minor to moderate impacts on the population, depending on the number of whales affected.

With the exception of the Cook Inlet beluga whale, the impacts, if large oil spills were to occur and contact cetaceans, range from negligible to moderate, depending on the species. Overall, potential impacts on fin, humpback, blue, sei, northern right, or gray whales are expected to range from negligible to moderate, depending on the number of whales contacted by a spill and the number of spills. In general, impacts to the Cook Inlet beluga whale population are expected to be minor. However, moderate to major impacts could occur, given the current decline in the population, if a large spill were to occur and contact individual beluga whales.

Due to the declining population of Steller sea lions, effects of large spills could be major if numerous or large rookeries were contaminated, resulting in high pup and adult mortality. Potential impacts of large oil spills that contact Pacific walrus and fur seals would be minor to moderate. Overall, if oil spills were to occur within the Beaufort and Chukchi Sea Planning Areas, effects on ringed, bearded, spotted, and ribbon seals would be minor to moderate.

Oil spills present the greatest potential threat to negatively impact marine and coastal bird species in the arctic and subarctic. If a large oil spill were to occur and contact bird habitat, potential impacts to threatened or endangered birds, as well as nonlisted bird species, could range from minor to major. The severity of impacts depends on the size, time, and location of the spill, and the environmental conditions present at the time of the spill.

Potential impacts on fish resources include acute, lethal effects of seismic surveys on fish eggs and larvae, and effects of artificial island construction in the arctic. These impacts could be moderate. Potential impacts to fish resources from oil spills depend on the species, numbers present, and life stage, as well as the time, location, and circumstances of the spill. At the regional level, impacts from oil spills are predicted to be minor. If a tanker spill were to occur in the Gulf of Alaska during fishing season, minor to moderate impacts to commercial fishing could occur in the Gulf of Alaska.

Routine operations that may impact the Stefansson Sound Boulder Patch and other seafloor habitats are pipeline burial and gravel island construction, which increase turbidity and sedimentation. The Boulder Patch would probably recover quickly from minor changes in turbidity and sedimentation. Moderate impacts would only occur if construction occurred within the Boulder Patch community.

The proposed action would expand existing land-use infrastructure and transportation systems. While the Prudhoe Bay complex can provide logistical support for Beaufort Sea OCS exploration and development, no such facilities currently exist for the Chukchi Sea and Hope Basin subregions. This could permanently alter the area's land-use patterns. The community of Kotzebue, the uninhabited areas around the Chukchi Sea and Hope Basin landfalls, and the pipeline route from the Chukchi Sea landfalls to TAPS will experience the greatest changes in land use. Potential impacts on land use and existing infrastructure due to routine operations are predicted to be moderate for both arctic and subarctic areas.

Diverse subsistence activities take place in all Alaska coastal regions potentially affected by the proposed action. Generally, potential impacts on sociocultural systems from routine operations under the proposed action would be minor to moderate, with less significant effects expected in areas already experiencing oil and gas development, namely, Cook Inlet. Potential impacts on sociocultural systems from accidents under the proposed action could range from minor to major, depending on the size, location, and timing of oil spills. Alaska Native populations are present in many coastal areas of Alaska. It is possible that new onshore infrastructure could be located near these populations and produce adverse health or environmental impacts if there were effects on subsistence foods and/or harvest patterns. If a large oil spill were to occur, it is possible that the potential environmental and health impacts on Alaska Native populations could be disproportionately high and adverse depending on the geographical location of the spill and the effects this spill may have on subsistence resources. Mitigation would not eliminate disproportionately high and adverse impacts; however, it could reduce them.

The Arctic National Wildlife Refuge (ANWR) is susceptible to oil spilled from subsea pipelines or drilling platforms in the Beaufort Sea. If a large spill were to occur, oil contamination of this shoreline would affect coastal fauna and subsistence use. Under such circumstances, impacts would range from minor to moderate.

Slowing the pace of leasing (alternative 2) will reduce the number of sales in the Beaufort Sea from three to one or two, and in the Chukchi Sea, Hope Basin, and Cook Inlet from two to one. There would be a corresponding reduction in the level of exploration, development, and production activity. There would be no change in the number of sales or the anticipated oil and gas activity in Norton Basin. Because there would be fewer helicopter trips to facilities in the Beaufort Sea, Chukchi Sea, and Hope Basin, there will be less noise disturbance to terrestrial mammals, including caribou, muskox, arctic fox, and grizzly bear. There would also be less chance of oil spills occurring and contacting the shoreline and coastal habitats. However, the difference between alternative 2 and the proposal in terms of oil-spill effects on biological resources would only be evident if multiple spills, assumed to occur under the proposed action, were to occur back to back without intervening recovery of the resources. If alternative 2 is adopted, there will be less chance of multiple oil spills occurring and contacting the shoreline along the northern border of ANWR, improving the chances of recovery for coastal fauna contacted by oil. Employment and regional income impacts would be somewhat less if fewer sales were conducted, although the sales remaining in the leasing schedule will ensure sufficient activity to sustain an effect on population, employment, and regional income at the same level as the proposed action. In general, the impacts of conducting fewer sales in the Beaufort Sea, Chukchi Sea, Hope Basin, and Cook Inlet Planning Areas will result in somewhat less impacts locally for some resources, although the overall impact level for all resources is expected to be the same as for the proposal.

If there were no sales in the Hope Basin or Norton Basin Planning Areas (alternative 3), none of the impacts expected for alternative 1 as a result of sales conducted in those areas would occur. Leasing would still be conducted in the Beaufort Sea, Chukchi Sea, and Cook Inlet, and the anticipated oil and gas activity in those three planning areas would be the same as for the proposal. Only natural gas is expected to be produced for local consumption in Hope Basin and Norton Basin under the proposal. Because no oil production is anticipated in these two areas, there is no risk of oil spills, which are the major environmental concern associated with OCS activity. Consequently, while alternative 3 eliminates impacts to all affected resources locally in Norton Basin and Hope Basin, the impacts overall to these resources throughout Alaska would be at the levels described for the proposed action.

If five sales were conducted in the Beaufort Sea during the 2002-2007 period (alternative 4), there would be a corresponding increase in the levels of OCS activities and related disturbances described for the proposal. Overall, if sales were held annually in the Beaufort Sea, it is expected that the overall impact levels for all affected resources except bowhead whales and sociocultural systems would be the same as those predicted for the proposed action. Additional sales in the Beaufort Sea Planning Area are likely to extend drilling and production activities into deeper waters. As a result, migrating bowhead whales may be more affected by noise disturbance associated with routine activities at platforms further from shore, and impacts are predicted to be moderate, compared to minor to moderate impacts for the proposal. Also, conducting annual sales in the Beaufort Sea could have potentially major effects on the sociocultural systems in the region. Resistance to increased operations among local subsistence harvesters would result in conflict among industry, government, and local people that may have prolonged impacts.

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APPENDICES

CHAPTER 1. PURPOSE AND NEED FOR THE PROPOSED ACTION

1. PURPOSE AND NEED FOR THE PROPOSED ACTION

1.1. Introduction

Section 18 of the Outer Continental Shelf (OCS) Lands Act (43 U.S.C. 1344) requires the United States Department of the Interior (USDOI) to prepare a 5-year schedule that specifies, as precisely as possible, the size, timing, and location of areas to be assessed for Federal offshore oil and gas leasing. The purpose of the proposed action is to establish a schedule for leasing OCS lands for oil and gas production that will best meet the Nation's energy needs for the next 5 years in a manner that is consistent with protection of the coastal environment and that demonstrates respect for State laws, goals, and policies.

The OCS Lands Act also requires the 5-year leasing schedule to be developed and maintained in a manner that is consistent with several management principles. Specifically, the USDOI must manage the OCS program in a manner that ensures a proper balance among oil and gas production, possible environmental degradation, and adverse impacts on the coastal zone. In developing the 5-year leasing schedule, the USDOI is obliged to consider regional and national energy needs; leasing interests as expressed by possible oil and gas producers; applicable laws, goals, and policies of affected States; competing uses of the OCS; relative environmental sensitivity among OCS Regions; and the fair market value of the hydrocarbons that are produced. The need for the proposed action is to establish a framework for managing the OCS oil and gas leasing program in a manner that accounts for all these factors. It is also needed to provide the potentially affected public with a clear statement of the USDOI's OCS leasing intentions during the period from 2002-2007.

The benefits of producing oil and natural gas from the OCS include helping to meet national energy needs and generating money for public use. Through 1999, the OCS produced more than 141 trillion cubic feet of natural gas. Natural gas generated from OCS leases represented more than 25 percent of 1999 domestic production. More than 12 billion barrels of oil also have been produced from the OCS. About 25 percent of the oil produced in the United States in 1999 came from the OCS. The OCS is estimated to contain more than 50 percent of the Nation's remaining undiscovered oil and natural gas resources. On average, the Federal Government receives almost $3.5 billion per year from OCS bonuses, rental payments, and royalties from offshore oil and gas leases.

According to the National Energy Policy (National Energy Policy Development [NEPD] Group, 2001):

> "U.S. energy demand is projected to rise to 127 quadrillion Btu by 2020, even with significantly improved energy efficiency. However, domestic production is expected to rise to only 86 quadrillion Btu by 2020. The shortfall between projected energy supply and demand in 2020 is nearly 50 percent. That shortfall can be made up in only three ways: import more energy; improve energy efficiency even more than expected; and increase domestic energy supply."

Production of OCS oil and gas resources is one of the prime methods for increasing domestic energy supply. Indeed, the National Energy Policy makes the following recommendation:

> "The NEPD Group recommends that the President direct the Secretary of the Interior [to] continue OCS oil and gas leasing and approval of exploration and development on predictable schedules." In addition, the NEPD Group recommends the

> consideration of "economic incentives for environmentally sound offshore development where warranted by special circumstances . . . ."

The OCS is divided into 26 planning areas. Eight of the planning areas have been identified for leasing consideration as part of the proposed program covering the period 2002-2007. The proposed program is the "proposed action" that is evaluated in this environmental impact statement (EIS). Eight planning areas located off the east and west coasts and off Alaska, and most of the Eastern Gulf of Mexico Planning Area located off Florida, are neither part of the proposed action nor analyzed in any alternative because they were withdrawn by the President from leasing consideration until after June 30, 2012. Other planning areas on the Alaska OCS were also excluded from the proposed program primarily because they have low oil and gas resource value and are of little or no interest to the oil and gas industry at this time.

The proposal distributes 20 sales among the eight OCS planning areas being considered for leasing. Twelve sales would occur in the Gulf of Mexico, and eight sales would occur offshore Alaska. The proposed action does not include any leasing off the east or west coasts of the continental United States. This EIS presents a program-level assessment of the potential environmental effects of holding those 20 sales. The EIS also evaluates the possible impacts of four alternatives to the proposed action. Subsequent environmental analyses will be conducted that more specifically evaluate the lease sales that are included in the final program for 2002-2007.

1.2. The Scope of the EIS

The content of an EIS is based on a process called "scoping." The regulations implementing the National Environmental Policy Act (NEPA) require that scoping be included in the environmental analysis process. Scoping for this EIS included several key elements: (1) gathering information and ideas from the public and elsewhere about the analytical issues related to the oil and gas leasing program; (2) making determinations about which issues should be analyzed; and (3) identifying alternatives to the proposal that warrant analysis. The scoping process is dynamic in that it begins before the draft EIS analyses are initiated and continues throughout the period of document preparation.

Several techniques were used to gather information from the public on the scope of this EIS. First, the Minerals Mangement Service (MMS) published a notice in the *Federal Register* (FR) (65 FR 77665; December 12, 2000) inviting the public to identify environmental issues that should be addressed. Additional comments related to the scope of this EIS were received as part of the public response to the request published in the FR asking for comments on the draft proposed program (66 FR 38314; July 23, 2001). Sources of the responses included Federal, State and local government agencies; businesses (e.g., petroleum, tourism, fishing) and public interest groups (e.g., environmental); and private citizens. The MMS also received input on the scope of this EIS during meetings that were held with potentially affected parties. For example, the MMS held meetings in coastal Alaska villages (such as Barrow, Point Hope, Kaktovik, Homer, and Soldotna) to get views and recommendations on the proposed action and scope of this EIS. Refer to Chapter 5 (Consultation and Coordination) for more information about the public input.

Additional information on the possible scope of this EIS was developed through an MMS review of the issues raised during preparation of EIS's for recent OCS oil and gas lease sale proposals for the Gulf of Mexico and offshore Alaska. Many of the analytical issues raised during the lease sale review process are applicable to this EIS for the proposed 5-year leasing program for 2002-2007. Environmental resource specialists at MMS who have knowledge about possible 5-year program activities and the potentially affected resources also identified analytical issues relevant to this analysis.

The sources of information used to develop potential alternatives to the proposed action were essentially the same as those used to identify analytical issues. Alternatives were suggested by the public in response to the requests for EIS input published by MMS. In addition, alternatives developed for past leasing program proposals were reviewed to determine whether it would be appropriate to analyze any of them in detail in this EIS.

The information gathered on the scope of this EIS generally fits into one of four categories:

- Oil and gas activities that could cause impacts (termed "impact producing factors");
- Ecological, social, and economic resources that could be affected by oil and gas activities;
- Alternatives to the proposed action; and
- Measures to mitigate the potential environmental impacts of the proposed action.

A summary of the analytical issues (which include both impact producing factors and the resources that might be affected), alternatives, and mitigating measures that were identified during scoping is presented below. None of the mitigation measures identified during scoping are analyzed in this EIS. However, the EIS impact analyses do assume implementation of mitigation measures required by statute or regulation as well as sale-specific mitigation (stipulations) commonly adopted in past sales (Appendix D. Assumed Mitigation Measures).

1.2.1. Issues Analyzed in This EIS

1.2.1.1. Impact-Producing Factors

Numerous types of impact-producing factors were identified that warrant consideration. All of the following impact-producing factors are included in the scenarios for the proposed action (Section 4.3.1), the alternatives (Sections 4.4.1, 4.5.1, and 4.6.1). In addition, the scenario for the cumulative impact analysis includes activities unrelated to OCS development but relevant to assessing cumulative impacts (Section 4.8.1).

- Accidental **oil spills** including those from well "blowouts," production accidents, and transportation system (e.g., tankers vessels, and seafloor pipelines) failures.
- **Liquid waste** disposal including well drilling fluids, produced water, and domestic wastewater generated at offshore facilities.
- **Solid waste** disposal including material removed from the wellbore (i.e., drill cuttings), solids produced with the oil and gas (e.g., sands), and trash and debris (e.g., equipment or tools) accidentally lost.
- **Gaseous emissions** from offshore and onshore facilities and transportation vessels and aircraft.
- **Noise** from seismic surveys, aircraft, and drilling and production offshore.
- **Traffic** including oil tankers and barges, and crew, supply, and seismic survey vessels and aircraft.
- **Physical emplacement, presence, and removal of facilities** including offshore platforms, seafloor pipelines, “floating production, storage, and offloading systems,” and onshore processing facilities.
- **Other activities or accidental events** including oil-spill responses (cleanup).

In addition to the activities that might result from the proposed action, this EIS analyzes natural phenomena that might cause indirect impacts by affecting the safe conduct of OCS oil and gas exploration, production, or transportation activities. The following phenomena are among those addressed in Section 4.1.4 of this EIS.

- **Geologic hazards** including earthquakes.
- **Physical oceanographic processes** including water currents, sea ice, and waves.
- **Subsea permafrost** in the arctic.
- **Meteorological phenomena** including hurricanes.

1.2.1.2. Potentially Affected Resources

We received suggestions to discuss in the EIS the contribution of the OCS program to global climate change and the potential for oil and gas activities to contribute to the introduction of invasive species. These topics are addressed in Section 4.1. Discrete analyses of potential OCS program impacts on the National Aeronautics & Space Administration (NASA) and U.S. Department of Defense use areas, global climate change, and invasive species are included in Section 4.1. For each resource or resource group covered in this EIS, six specific analyses are presented: one for the proposed action (Section 4.3), one for each of the four alternatives (Sections 4.4, 4.5, 4.6, and 4.7), and one for the cumulative scenario (Section 4.8). The resources and topics analyzed are listed below.

- **Water quality** including marine and estuarine areas. The water quality issues raised are related primarily to marine water quality and were generally raised in the context of how changes in water quality caused by OCS activities could affect biological resources
- **Air quality.** The principal concern identified with respect to air quality is the possible effects of offshore emissions on onshore air quality and the potential for offshore emissions to contribute to violations of onshore air quality standards.

Issues raised regarding possible impacts on biology and ecology fall into three main categories: animals, plants, and habitats or ecological systems. Among the animal groups identified as needing analysis for potential program impacts were marine mammals (e.g., whales, seals, sea lions), birds (e.g., waterfowl, seabirds), fish (e.g., salmon), and sea turtles. Special attention was drawn to migratory species (including whales, fish, birds) and the threatened and endangered species. Seagrass was identified as a plant species being potentially affected by activities associated with the proposed action. With respect to habitats or systems, both marine (i.e., sanctuaries, marine parks/preserves, and "hard bottom" areas), and coastal (i.e., estuaries, wetlands/marsh, intertidal zone, seashore parks) areas were identified as subject to possible adverse impacts. The specific biological and ecological resources analyzed in detail are listed below.

- **Marine mammals** including a variety of endangered and nonendangered cetaceans (whales), pinnipeds (seals, sea lions, walruses), sea otters, and polar bears.
- **Terrestrial mammals** including caribou in the arctic and three species of mice that inhabit certain coastal areas of the Gulf of Mexico.
- **Birds** including a variety of endangered and nonendangered seabird, shorebird, waterfowl, and raptor species. Particular concern was identified for migratory species.
- **Fish** including a variety of finfish and shellfish species used for commercial or recreational purposes. Particular concern was identified regarding chronic salmon pollution with polycyclic aromatic hydrocarbons based on the *Exxon Valdez* oil-spill studies.
- **Reptiles** limited to sea turtles.
- **Coastal habitats** including wetlands, estuaries, seagrass beds, and barrier islands.

- **Seafloor habitats** including submarine canyons, topographic features, corals, and "live bottom" areas.
- **Areas of special concern** including coastal and marine sanctuaries, parks, refuges, reserves, sanctuaries, and forests. Particular concern was raised in regard to “essential fish habitat” as designated by the United States Department of Commerce (USDOC), National Marine Fisheries Service (NMFS).

Concerns about the possible socioeconomic impacts of implementing the proposed action were identified more often than any other type of analytical issue. Specific concerns included potential impacts on tourism, recreation, commercial fishing, aesthetics, local economy (especially the "boom/bust" phenomenon), land- and water-use conflicts, and disproportionate impacts on Alaska Natives. The socioeconomic topics analyzed in this EIS are:

- **Coastal community issues** including population, employment, land use, regional income, and public services. Particular concern was identified regarding shoreline industrialization and land- and water-use conflicts in the coastal area.
- **Sociocultural systems** effects were primarily identified for Alaska. These included concerns about the effects on subsistence (e.g., bowhead whale hunting), loss of cultural identity, psychological health of people, and social cost of oil spills. Of particular concern was “environmental justice” (Executive Order 12898), which deals with disproportionate and high adverse impacts on minority and/or low-income populations.
- **Fisheries**, both commercial and recreational.
- **Recreation and tourism** including the use of coastal areas for sightseeing, wildlife observations, swimming, diving, surfing, sunbathing, hunting, fishing, and boating. Of particular concern was the “visual impact” of offshore OCS facilities.
- **Archaeological resources** including historic shipwrecks and sites inhabited by humans during prehistoric times.

A number of suggestions were made regarding the methods that should be used to analyze the potential impacts of the proposed action. The following suggestions regarding analytical methods are incorporated in this EIS.

- **Traditional knowledge:** Include the Native or traditional knowledge in the EIS assessment in addition to the western science information. Such knowledge is incorporated in the EIS primarily in regard to Alaska Natives and in reference to sociocultural and marine mammal resources.
- **Coastal Zone Management Act (CZMA) and consistency determination (CD):** Indicate in the EIS how the 5-year program intends to ensure full compliance with the CZMA including submittal of a CD. Appendix E (Federal Laws and Executive Orders) in this EIS describes the Federal consistency requirements contained in the CZMA.
- **Energy needs and alternative energy:** Present information in the EIS on the nation’s energy needs and alternatives, including those other than offshore oil and gas, that may supply that need. This information is presented in this EIS in Section 1 (Purpose and Need for the Proposed Action) and Section 4.7 (No Action Alternative). A related suggestion, that there be a demonstration of how oil and gas development is balanced with other uses of the OCS and the preservation and protection of renewable resources, is presented separately in the program decision document.
- **Environmental risk and impact:** The assessment of the risk of a large oil spill should be presented separate from the potential impacts should such a spill occur. The EIS analysis of the proposed action (Section 4.3) presents the consequences of large spills for all resources independent of risk. The risk of spill occurrence is then presented separately.

- **Cumulative impacts:** Present the cumulative impacts of OCS oil and gas exploration and development for each specific resource on a national or regional scale. The cumulative analysis for a resource is presented on a planning area and regional (Gulf of Mexico, Alaska, and Pacific) basis (Section 4.8). Consideration of larger areas is given for species (e.g., grey whales) that migrate through more than one planning area or region.

1.2.2. Issues Not Analyzed in this EIS

The following discussions address issues mentioned during scoping that were not analyzed in this EIS. These issues included concerns about affected resources or use of analytical techniques in the EIS.

1.2.2.1. Human Safety

Generally, concerns mentioned about human safety from OCS oil and gas development were broad and not defined during scoping. However, one specific comment dealt with the concern that oil spilled in the Arctic OCS may become trapped in the ice, making it less stable for travel across the ice. This concern is discussed in detail in this EIS in Appendix C (Oil-Spill Response Capabilities for Offshore Oil and Gas Operations). Otherwise, the issue of worker safety is more appropriately considered during the review of individual lease exploration and development proposals. The OCS Lands Act and the implementing regulations require that all drilling and production operations use the best available and safest technologies. A principal reason for this requirement is to minimize the adverse effect of OCS operations on human safety. It is during the review of proposals to conduct lease operations that MMS considers whether they would be conducted in a manner that conforms with the many specific requirements developed to protect human safety. The MMS can best determine at that time whether additional measures are needed to reduce the potential for accidents that affect safety.

1.2.2.2. Human Health

The concerns expressed about human health were generally broad and not associated with specific proposed action activities. Treatment of possible highly adverse effects on human health are limited in this EIS to the disproportionate effect analyses in regard to environmental justice (Section 4.3).

1.2.2.3. Proposed Oil Drilling Activity in the Pacific Region

It was suggested that the proposed drilling of delineation wells on active leases offshore California should also be fully evaluated in this 5-year program EIS as part of the cumulative impact. However, Council on Environmental Quality and U.S. Environmental Protection Agency (USEPA) guidance emphasize that Agencies should limit the scope of the cumulative scenario to actions, geographic areas, and time periods that are relevant to decisionmaking for the proposed action. The Secretary of the Interior will make decisions for the 5-year program concerning leasing in the Alaska and Gulf of Mexico Regions, but not in the Pacific Region, for the period 2002-2007. The environmental effects of current oil and gas activities in southern California are not expected to contribute to the cumulative impacts of leasing decisions in the Alaska or Gulf of Mexico OCS Regions. Therefore, oil and gas activities in southern California are beyond the scope of this 5-year program EIS.

A more appropriate document for addressing this matter is the Draft EIS on Proposed Delineation Drilling Activities in Federal Waters Offshore Santa Barbara County, California, which was filed with the USEPA and distributed to the public in June 2001. It contains an analysis of the cumulative impacts associated with the drilling of the delineation wells and the cumulative analysis of all OCS-related oil and gas activity expected in the reasonable foreseeable future in the area.

1.2.2.4. Biological Assessment and Opinion for Threatened and Endangered Species

As regards the assessment of threatened or endangered species, several suggestions were made that the EIS include a biological assessment and associated U.S. Fish and Wildlife Service (FWS) and USDOC, NMFS, biological opinion or formal concurrence. Such information is not included in this EIS.

Section 7(a)(2) of the Endangered Species Act (ESA) requires every Federal Agency, in consultation with and with the assistance of the Secretary, to ensure that any action it authorizes, funds, or carries out in the United States or upon the high seas is not likely to jeopardize the continued existence of any listed species or result in destruction or adverse modification of critical habitat. Section 402.02 defines "action" as "all activities or programs of any kind authorized, funded, or carried out in whole or in part . . . ." Preparing the proposed 5-year program does not fit the definition of a Federal action, and ESA Section 7 consultation (whether informal or formal) at the 5-year program level is premature.

The 5-year program, as required by Section 18 of the OCS Lands Act (43 U.S.C. §1344) identifies a proposed schedule of lease sales and prospective areas of the OCS which the Secretary believes will best meet the Nation's energy needs. The 5-year program process and subsequent Secretarial decisions are based on the four main principles of Section 18 that dictate which areas are reasonable for consideration of leasing in the upcoming 5-year timeframe. The proposed 5-year program defines, as broadly as possible, the portion of each planning area that is proposed for subsequent leasing consideration. Decision options for the 5-year program are preserved for the Secretary at the time the decision is made for each sale. Therefore, it is at the lease sale stage that MMS begins ESA Section 7 consultations.

In further support of the position not to consult at the 5-year program stage, the FWS and NMFS in their final rulemaking establishing procedural regulations for Section 7 consultations (51 FR 19926) clarified that informal and formal consultations are a "post-application process when applicants are involved." The MMS would not approach this stage until a lease sale is held and a qualified bid is accepted. Further, we believe the intent of Congress when passing the ESA was to exclude consultations on actions that are remote or speculative in nature. While the following quote addresses ESA Section 7 early consultations (a pre-application process defined in the above referenced FR Notice), we believe it clearly expresses Congress' intent and is consistent with our position.

> "The Committee expects that the Secretary will exclude from such early consultation those actions which are remote or speculative in nature and to include only those actions which the applicant can demonstrate are likely to occur. . . . The Committee further expects that the guidelines will require the prospective applicant to provide sufficient information describing the project, its location, and the scope of activities associated with it to enable the Secretary to carry out a meaningful consultation." (H.R. Rep. No. 567, 97th Cong., 2nd Sess. 25 [1982])

Ultimately, decisions regarding the size and configuration of a lease sale area, lease stipulations, and some mitigation measures are determined by the presale process. Prior to the presale process, greater uncertainties exist. Some of the uncertainties may result from an industry firm's interest in a particular area and their willingness to bid, which depend, in part, on continually changing perceptions about potential payoffs that might result. Additionally, our limitation on predicting a firm's investment decisions also limits our ability to predict OCS activities.

1.2.2.5. Life Cycle Effects of Oil and Gas Development

A recommendation was made that the EIS address all reasonable effects of new oil and gas development, production, and consumption. Such "full cycle" effects would include oil and gas exploration, construction, continued drilling, production, processing, treatment, refining, transportation and storage, final decommissioning, and ultimate consumption of the finished product. Additionally, the contribution of OCS development and consumption activities to global warming was stressed.

The scope of the proposed action analyzed in this EIS encompasses the exploration, development, production, and transport of crude oil, and decommissioning. The consumption of the refined oil is not considered because the scope of this EIS is limited to issues that have a bearing on the decisions for the proposed leasing program. Consumption of oil and gas is considered at a broader level when decisions are made regarding the role of oil and gas generally, including domestic production and imports, in the Nation's overall energy policy. At the refinery stage, OCS oil is mixed with oil from other sources such that the OCS contribution to subsequent environmental impacts is not discernible.

1.2.2.6. Impact Definitions for Threatened and Endangered Species

A suggestion was made that the impact level definitions for threatened and endangered species should be different than the definitions for nonthreatened and nonendangered species to reflect their special vulnerability. We agree that an adverse impact to threatened and endangered species would be more significant than to nonthreatened and nonendangered species. The threatened and endangered species are analyzed separately in this EIS to acknowledge their special status. However, the impact levels used (Section 4.2) reflect vulnerability and recoverability, and therefore apply to all species.

The measurement of severity of an impact should not be confused with the sensitivity of the resource to impact-causing activities. Because endangered species are usually more sensitive than non-endangered species, a given activity will most often result in more severe overall impact for the endangered species than for a nonendangered one. For example, a given activity may cause a minor impact to a non-endangered species but a moderate impact to an endangered species. This does not mean, however, that the minor and moderate impacts are defined differently.

1.2.2.7. Overall Impact Conclusions

A suggestion was made that overall impact conclusions should be avoided in the EIS. The concern is that such conclusions do not distinguish sensitivities of some individual species and that synergistic and antagonistic effects may be masked. The EIS addresses the species-specific sensitivities and synergistic and antagonistic effects in the body of the analysis for each resource. However, we continue to use the overall impact conclusions because they provide valuable information for decisionmakers and the public, and an effective means for comparing alternatives.

1.2.2.8. Resource Estimates and Impact Analyses

A concern was expressed that oil-resource reserves should not be linked to conclusions for environmental impacts. It was felt that low oil-resource estimates, and subsequent low probabilities of commercial finds, may erroneously be equated with insignificant environmental impacts. The EIS does not equate oil-resource estimates and impact significance. We assess the potential impacts of a large spill on environmental resources regardless of the oil-resource estimate, and analytical conclusions reflect the likely impacts if a large spill were to occur and contact the resource. The likelihood of spill occurrence is presented separately. However, the estimated number of large spills that could occur is a function of the oil-resource estimate. Therefore, the impacts could be greater to some environmental resources because they could be exposed to more large spills than other environmental resources.

1.2.3. Alternatives Analyzed in This EIS

Four principal types of alternatives to the proposed action were identified from scoping:

- Slow the rate at which future OCS lease sales are held in some planning areas;
- Exclude from leasing consideration some of the planning areas included in the proposed action;
- Accelerate the rate at which future OCS lease sales are held in some planning areas;
- Develop alternative energy sources and/or adopt conservation measures in lieu of continued OCS oil and gas leasing.

Three principal criteria were used as the bases for determining whether a potential alternative was reasonable for the purpose of analyzing it in detail in this EIS. First, the structure of the alternative had to be related to the issues of size, timing, or location of possible future lease sales. This is consistent with the OCS Lands Act requirement that the USDOI develop a schedule of potential lease sales that specifies, as precisely as possible, the size, timing, and location of those sales. Second, the alternative could not be redundant with one or more elements of other alternatives that were already being analyzed in this EIS. Finally, it must be consistent with the management principles and other considerations included in Section 18 of the OCS Lands Act. Each of the following alternatives except the No Action alternative reflects consideration of these criteria.

1.2.3.1. Slow the Pace of Leasing

Several options for slowing the rate of development were suggested for consideration in this EIS. The principal objective and advantage of a slow-the-pace alternative is to give affected governments and communities more time to plan for and address sale related impacts. The option analyzed in this EIS would reduce the number of lease sales included in the proposed action for the Eastern Gulf of Mexico, Beaufort Sea, Chukchi Sea, Hope Basin, and Cook Inlet Planning Areas. See Section 2.2 for a complete description of this alternative (Alternative 2) and Section 4.4 for its environmental impacts.

1.2.3.2. Exclude Some Planning Areas

Exclusion of entire planning areas was suggested in Alaska and the Gulf of Mexico Regions. This alternative considers the effects of excluding Norton Basin and Hope Basin Planning Areas in Alaska and the Eastern Gulf of Mexico Planning Area. These planning areas were included in the proposed action (Alternative 1).

Some of the planning areas suggested for exclusion are not indicated as part of the proposed action. These additional planning areas excluded from the proposed action are St. Matthew Hall, Navarin Basin, St. George Basin, Bowers Basin, Aleutian Arc, North Aleutian Arc, Aleutian Basin, Shumagin, Kodiak, Gulf of Alaska, Oregon/Washington, Northern California, Central California, Southern California, North Atlantic, Mid Atlantic, South Atlantic, and the Straits of Florida (Figure 2-1). See Section 2.3 for a description of this alternative (Alternative 3) and Section 4.5 for its environmental impacts.

1.2.3.3. Accelerated Leasing

Options to accelerate the rate of OCS leasing were suggested, especially in regard to the Beaufort Sea Planning Area and the Eastern Gulf of Mexico Planning Area. The option analyzed in the EIS would increase the number of lease sales included in the proposed action for the Beaufort Sea and Eastern Gulf of Mexico Planning Areas. See Section 2.4 for a complete description of the alternative (Alternative 4) and Section 4.6 for its environmental impacts.

1.2.3.4. No Action

An analysis of the potential effects of not adopting an OCS Oil and Gas Leasing Program for 2002-2007 is required by the regulations that implements NEPA (40 CFR 1502.14(d)). The No Action alternative considers the nature of the environmental impacts that might occur in absence of the potential development attendant to the proposed action. The analysis includes the possible environmental impacts of the most likely mix of market-driven substitutes for the energy (including oil imports) that might be produced if the proposed action was implemented. It also considers the impacts of developing other sources of energy (e.g., non-petroleum fuels, solar, nuclear, conservation) that might substitute for some oil and natural gas produced from the OCS. See Section 2.5 for a complete description of the alternative (Alternative 5) and Section 4.7 for its environmental impacts.

1.2.4. Alternatives Not Analyzed in This EIS

1.2.4.1. Exclude Portions of Planning Areas

Requests were received to exclude specific portions of planning areas. The most frequently recommended area for exclusion from the 5-year leasing program was the area offshore and adjacent to the Arctic National Wildlife Refuge in the Beaufort Sea Planning Area.

The Secretary removed portions of some planning areas from leasing consideration for the proposed program at the request of the governors of the States of Florida and Alaska. However, the environmental analysis conducted to support the 5-year program decision should not assess the consequences of excluding additional blocks in a given planning area. Alternatives to remove some blocks from a particular sale, such as the area offshore and adjacent to ANWR, require a focused analysis within a specific planning area. Such an analysis is performed for each sale or group of sales and ensures that the Secretary makes a fully informed decision about the actual blocks to offer for lease at the appropriate time, namely, when a Final Notice of Sale is issued for each sale.

We have more environmental and technical information from our studies, other agencies, industry, and the public at the lease sale stage to support more informed decisions about which blocks to offer. Reserving block-specific decisions until the lease sale stage ensures those decisions are made with the most current information.

Lease-sale stipulations are developed or refined for particular blocks within a proposed sale area during the lease sale process. Most stipulations contain mitigation measures that protect the environment from oil and gas activities. Some blocks that could be leased with these protective measures may be excluded unnecessarily if we consider block deferral alternatives at the 5-year program stage.

1.2.4.2. Exclude All Alaska Planning Areas

Some requests were received to exclude the entire Alaska OCS from leasing consideration in the 2002-2007 leasing program. Among the reasons for requesting this alternative were that the Alaska planning areas were too sensitive and fragile to sustain extended industrial development without unacceptable risk, that there is already enough oil development in Alaska, and that there is an inability to clean up spilled oil in Alaska waters.

To exclude all Alaska planning areas would not be reasonable in light of the purpose and need for the oil and gas leasing program, which is to meet the Nation's energy needs in a manner consistent with environmental protection and the laws and policies of affected States. The leasing schedule must ensure a proper balance between oil and gas production and possible environmental impacts, while also considering relative environmental sensitivity among OCS Regions and competing uses of the OCS. Furthermore, the potential effects of excluding the entire Alaska OCS from the 2002-2007 leasing program are disclosed in the analysis for the no-action alternative.

1.2.4.3. Lease Entire Planning Areas (Areawide) in Alaska

A number of industry commenters requested that sales in Alaska for the 5-year program, especially in the Beaufort Sea and Cook Inlet Planning Areas, offer entire planning areas ("areawide" leasing). It was stated that this would provide flexibility and predictability of sales in Alaska.

Such an alternative for areawide sales in Alaska was not considered as an alternative in this EIS because there are limitations in terms of technology, oil and gas resource potential, industry interest, and environmental sensitivity in the Alaska frontier areas. For instance, there is a question of both technological feasibility and interest to produce and transport oil from the deepwater areas of the Beaufort Sea Planning Area far from shore. Also, including these planning areas in their entirety would be contrary to the expressed wishes of the Governor of Alaska.

1.2.4.4. Include the Gulf of Alaska Planning Area

One commenter asked that the Gulf of Alaska be included for leasing in the 2002-2007 leasing program. Such leasing is not considered in this program or this EIS because of the lack of industry interest in this planning area. No oil company has indicated an interest in this area for the 2002-2007 program, and prior potential sales in this planning area under the last two 5-year programs have all been cancelled.

1.2.4.5. Include All 26 Planning Areas in the Program

The National Oceanic and Atmospheric Administration recommended that all 26 OCS planning areas be considered for leasing in the proposed 5-year program. The Secretary did not include numerous areas in the Proposed Program and Draft EIS that were issued in October 2001 for several reasons. First of all, major portions of the OCS were withdrawn by the President from leasing consideration until June 30, 2012. Other areas were not included because they have low oil and gas resource value and are of little or no interest to the oil and gas industry at this time. Finally, some areas were not included because of requests from governors of affected States and continuing concerns from local communities about environmental issues analyzed previously. These areas were not analyzed as alternatives in this EIS for the same reasons they were not included in the proposed action.

1.2.5. Mitigation Measures Not Analyzed in This EIS

1.2.5.1. Revenue Sharing

A number of comments were received from local governments and Alaska Native interests suggesting that locally affected communities receive a fair share of the revenues generated by the OCS oil and gas leasing program. This revenue sharing would be to mitigate adverse impacts for those communities bearing the principal impact and risk of the program. Specifically, the commenters requested "a mechanism to provide necessary compensation . . . should a catastrophic spill occur or a long-term significant chronic impact to environmental, or subsistence harvests be identified," also "impact aid to offset the costs of dealing with effects which have already occurred and are ongoing," and "impact assistance" for local communities for being "compelled to participate in the planning process associated with never-ending succession of lease sales and project proposals."

Current laws and proposed legislation that provide compensation or impact assistance to coastal States or communities are summarized below. Newly enacted legislation provides for a program of assistance to be administered by the Secretary of Commerce, rather than this Department. At this early stage in that program, any statements on the effect of such assistance on the environmental impacts analyzed in this EIS would be highly speculative. At the current level of authorization, the availability of such assistance is not a material factor in the determination of the size, timing, and location of lease sales within this 5-year schedule; therefore, further analysis of these proposals is beyond the scope of this EIS.

The Oil Pollution Act of 1990 (P.L. 101-380) includes comprehensive provisions pertaining to liability and compensation for both onshore and offshore oil spills. Title I of this Act provides for recovering costs relating to the following from a party responsible for an oil spill: removal, natural resource damage, real or personal property damage, lost subsistence use, lost tax revenue, lost profits and earning capacity, and increased public service expenses. Title I also established the Oil Spill Liability Trust Fund to be used to pay removal costs in accordance with the National Contingency Plan (under the Comprehensive Environmental Response Compensation and Liability Act of 1980); costs incurred by natural resource trustees; claims for uncompensated removal costs or damages; and administrative, operational, and personnel costs associated with administering the Act. Title IX of the Act includes provisions to increase limits of expenditure per incident from what they had been previously.

The Coastal Impact Assistance Program (CIAP), authorized by Congress under Section 903 of the Commerce, State and Justice Fiscal Year 2001 Appropriations Act, authorizes the Secretary of Commerce to distribute a portion of the OCS revenues generated from tracts seaward of the 8(g) zone to affected States and localities. The program generally is intended to support projects and activities relating to coastal stewardship, and it specifies "mitigating the impacts of Outer Continental Shelf activities" as a purpose for which the payments may be used by recipients. Congress appropriated $150 million for this CIAP for Fiscal Year 2001. For example, Alaska was authorized $12.2 million, of which $4.2 million was divided among 18 coastal boroughs and Coastal Resource Service Areas. According to the State of Alaska's CIAP, the North Slope Borough was allocated $1.9 million. The borough plans to use the CIAP funding on research regarding the diminishment of the borough's wildlife resources. In the Gulf of Mexico, Alabama was authorized $20.3 million. According to the State of Alabama's CIAP, Baldwin and Mobile Counties are allocated $3.1 million and 3.9 million, respectively. The two counties plan to use the CIAP funds for a wide range of projects, including such items as erosion and sediment control initiatives and watershed education and outreach.

While local communities do bear risks and impacts associated with OCS oil and gas leasing activities, they also may enjoy economic benefits in the form of increased employment or higher paying jobs. Although these benefits are not direct compensation, they can offset somewhat the adverse effects that may result from OCS oil and gas activities. The extent of these benefits depends on a number of factors. In arctic Alaska, one of the avenues for increased employment is oil company contracts with Native corporations or subsidiaries of such corporations. Oil companies now employ few North Slope Borough residents, but they have been working to recruit and provide training to residents. The benefits and impacts to local communities are analyzed in this EIS and program document.

The Conservation and Reinvestment Act, which proposes an impact assistance program funded at $1 billion per year, has been reintroduced in the 107th Congress as H.R. 701. Title I, Impact Assistance & Coastal Conservation, specifically refers to mitigation of impacts associated with OCS activity as one of the purposes for which impact assistance funds would be intended. The Administration has not stated a position on this proposed legislation.

1.2.5.2. Zero Discharge in Water

A suggestion was made that there should be no discharge of drilling wastes or produced water from OCS facilities into the receiving water; instead, the MMS would require that these substances be reinjected into underground reservoirs. Such a measure to prohibit in-water discharge is not analyzed in this EIS. It is more appropriate to consider such a measure during review of specific leasing proposals and during review of the subsequent development and production plans.

CHAPTER 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

This environmental impact statement (EIS) analyzes five alternatives for the leasing of Federal offshore lands by the U.S. Department of the Interior (USDOI), Minerals Management Service (MMS) for the period from mid-2002 to mid-2007:

- Alternative 1—Proposed Action
- Alternative 2—Slow the Pace of Leasing
- Alternative 3—Exclude Some Planning Areas
- Alternative 4—Accelerated Leasing
- Alternative 5—No Action

This chapter describes each alternative and summarizes the potential environmental impacts of the alternatives in comparative form. The summary describes the primary impacts based on the detailed analysis of all potential impacts presented in Chapter 4.

The EIS's impact analyses were generated from exploration, development, transportation, and oil-spill scenarios developed specifically for analytical purposes and are not indicative of future events. Additionally, the impact analysis conclusions use a four-level classification scheme to characterize the impacts: negligible, minor, moderate, and major. Definitions for the impact levels used by the analysts are provided in Section 4.2 and are generally based on a resource's ability to recover from an impacting agent. For example, the minor impact level means that most impacts to the affected resource could be avoided with proper mitigation. If impacts were to occur, the affected resource would recover completely without any mitigation once the impacting agent was eliminated.

2.1. Alternative 1—Proposed Action

2.1.1. Description

The four Outer Continental Shelf (OCS) Regions are divided into 26 OCS planning areas (Figure 2-1). The USDOI is considering leasing in two of the OCS Regions, the Gulf of Mexico and Alaska. Within the Gulf of Mexico OCS Region, leasing is being considered in the three Gulf of Mexico Region planning areas: Central, Eastern, and Western Gulf of Mexico Planning Areas. In addition, the USDOI is considering leasing in 5 of the 14 Alaska Region planning areas: Beaufort Sea, Chukchi Sea, Cook Inlet, Hope Basin, and Norton Basin. All other planning areas are not analyzed in this EIS because the USDOI is not considering those areas for leasing in the proposed 5-year program. The proposed action is the USDOI's preferred alternative.

Alternative 1—the Proposed Action calls for 20 sales:

- Central Gulf of Mexico—5 annual areawide lease sales (Figure 2-2).
- Eastern Gulf of Mexico—2 lease sales scheduled in 2003 and 2005, consisting of 256 deepwater tracts directly off Alabama and adjacent to the Central Gulf of Mexico Planning Area (Figure 2-2).
- Western Gulf of Mexico—5 annual areawide lease sales (Figure 2-2).
- Beaufort Sea—3 lease sales scheduled in 2003, 2005, and 2007 in an area identical to the program area adopted in the 1997-2002 program (Figure 2-3).
- Chukchi Sea/Hope Basin—2 lease sales that exclude nearshore tracts, the Chukchi Polynya, and tracts near Barrow (Figure 2-3).

- Cook Inlet—2 lease sales scheduled in 2004 and 2006 that exclude the Shelikof Strait portion and add blocks near Kachemak Bay that are not included in the 1997-2002 program (Figure 2-4).
- Norton Basin—a single "special-interest" lease sale (Figure 2-5).

The objective of the "special-interest" leasing option to be employed in the Norton Basin is to foster exploration in a frontier OCS area without investment of the considerable time and effort required for holding a typical lease sale. The general approach is to query industry regarding the level of interest in proceeding with a sale in an area that would offer only very small, very focused areas of specific interest for exploration. This leasing process is also being considered for the sales proposed in the Chukchi Sea/Hope Basin.

Activities that could occur as a result of the 20 lease sales in the proposal may extend over a period of 25-40 years. The impact-causing factors associated with these activities include the placement of offshore infrastructure such as rigs, platforms, and pipelines, and onshore facilities such as support bases and processing plants. Operational impacts include bottom disturbance from platform and pipeline placement, local water quality changes from discharging drilling fluids, and air and noise emissions from platforms, supply boats, and air traffic. The specific estimates of offshore infrastructure required to support exploration and development of the hydrocarbon resources (scenarios) associated with alternative 1 (the proposed action) are provided in Tables 4-1a and 4-1b.

Chapter 4 presents a detailed explanation of the basic assumptions, anticipated production, exploration, and development assumptions; transportation and market assumptions; and oil-spill assumptions used to prepare the EIS. Transportation for most oil and gas from the Western and Central Gulf of Mexico Planning Areas would be accomplished by extending and expanding and existing offshore pipeline systems. Very little of the oil from the nearshore areas of the Western and Central Gulf of Mexico Planning Areas and some of the oil in deepwater areas would be transported by barge or shuttle tanker. Natural gas and oil from deep waters of the Eastern Gulf of Mexico Planning Area would connect to existing pipelines or facilities in the Central Gulf of Mexico and would then be piped to shore.

In the Alaska Region, the lifting of the export ban on Alaskan crude oil has led to infrequent and limited shipments to East Asia. However, the vast majority of oil transported via the Trans-Alaska Pipeline System (TAPS) is still being sent to the U.S. west coast. Oil from the Beaufort Sea and Chukchi Sea Planning Areas would be transported by new subsea and overland pipelines to the TAPS and would eventually be carried to the marine terminal facilities in Valdez where it would be loaded on tankers and shipped primarily to west coast ports. Natural gas from the Hope Basin Planning Area would transported to shore by subsea pipeline to meet a growing local market for natural gas. Oil from the Cook Inlet Planning Area would be transported to shore using new subsea pipelines with new onshore common-carrier pipeline systems delivering the oil to existing refineries in Nikiski and gas to transmission facilities in the Kenai area. Natural gas from the Norton Basin Planning Area would be transported to shore by subsea pipelines and used by communities and industries centered in Nome, Alaska.

The accidental impact-causing event of principal concern is oil spills. Table 4-1e presents the number of large oil spills assumed to occur as a result of the production and transportation of oil associated with lease sales proposed in alternative 1. The sizes of the assumed spills are approximately equal to the mean of the historical spills for each spill type (platform, pipeline, tanker, or barge). The assumed spills sizes are: platforms—1,500 bbl; pipeline—4,600 bbl; and tankers—5,300 bbl for the Gulf of Mexico and 7,800 bbl for tankers carrying Alaska OCS oil. Assumptions regarding the location of spills are based on the source of the spill, the transportation and market assumptions, the location of existing infrastructure, and the location of the resources being analyzed. Platforms spills were assumed to occur in the area proposed for consideration for lease. Pipeline spills were assumed to occur between the proposed area for lease consideration and the existing infrastructure. Tanker and barge spills were assumed to occur along the tanker and barge routes.

Finally, the EIS analyses assume the implementation of all mitigation measures required by statute, regulation, or lease stipulations. The protection afforded by these measures is present in the analysis of the resources being mitigated.

2.1.2. Summary of Impacts

2.1.2.1. Impacts on Water Quality

Routine OCS activities potentially affecting water quality include structure placement and removal (e.g., platforms, drilling units, pipeline landfalls) and operational discharges and wastes. Structure placement and removal increase suspended sediment load in the water column resulting in temporary minor impacts on water quality. Operational discharges (muds, cuttings, produced water), sanitary and domestic waste, and deck drainage are regulated by the limitations in the National Pollutant Discharge Elimination System (NPDES) permits issued at the U.S. Environmental Protection Agency (USEPA) regional level. Compliance with NPDES permit restrictions would minimize impacts on receiving waters to a minor level. Water quality would recover without mitigation when discharges cease. If oil spills were to occur, impacts on water quality could range from minor to moderate depending on dispersion and weathering of spilled oil.

In the Gulf of Mexico, structure placement and operational discharges would have a minor effect on coastal water quality. Structure placement produces turbidity that can temporarily degrade affected waters; normal background concentrations of suspended solids will return when activity ceases and without mitigation. Confined portions of some channels may be unable to assimilate bilge water and sanitary wastes, thus resulting in some minor regional degradation. Compliance with U.S. Coast Guard regulations would assist in avoiding most impacts on such receiving waters. Overall marine water quality impacts from routine activities would be minor as compliance with NPDES permit requirements minimizes or avoids most impacts to receiving waters, and water quality would recover when discharges ceased. Oil-spill impacts to water quality could range from minor to moderate depending on dispersion and weathering of spilled oil.

In Alaska, placement and removal of pipelines, artificial islands, and platforms disturb the seafloor and temporarily increase the sediment load in the water column, resulting in minor impacts on water quality. Exploration discharges would persist for a few hours within the mixing zone around each rig; however, the NPDES permit limits discharge rates so the resultant impacts would be negligible to minor on water quality. Most major production facilities would reinject all muds, cuttings, and production waters, thus eliminating degradation of water quality by these effluents. A spill in isolated coastal waters or shallow water under thick or rapidly freezing ice could cause sustained degradation of water quality. Decomposition and weathering process for oil are slowed in cold water. The impact on water quality from spilled oil in these areas could be minor to moderate.

2.1.2.2. Impacts on Air Quality

The most commonly emitted air pollutants associated with OCS oil and gas activities include nitrogen dioxide (NO_x), sulfur dioxide (SO_x), 10-micron particulate matter (PM_{10}), carbon monoxide (CO), and volatile organic compounds (VOC). The most common NO_x sources associated with OCS activities are diesel engines used in construction, drilling and support activities; gas reciprocating engines; turbines; and support vessels. The NO_x combines with VOC under the influence of sunlight and high temperatures to form ozone. The USEPA has established national ambient air quality standards (NAAQS) for these pollutants and ozone. The overall impact from pollutants associated with routine oil and gas activities on air quality is expected to be minor; ozone contributions from the proposed action could have a negligible affect on air quality. Air quality impacts from oil spills and in-situ burning could be localized and of short duration and could also cause minor impacts on air quality.

In the Gulf of Mexico, existing concentrations of pollutants are well within the NAAQS. The emissions associated with the proposed 5-year program would result in only a very small increase in concentrations, and total levels would remain well within the NAAQS. Ambient ozone concentrations presently exceed the Federal standard in several Gulf coastal areas. The contribution from existing OCS emissions is small (at most about 2% of the total concentrations). The added contribution from the proposed 5-year program would be much smaller than this figure. Air quality impacts from oil spills and in-situ burning could be localized and of short duration and could cause minor impacts on air quality.

In Alaska, the concentrations of NO_x, SO_x and PM_{10} and CO would remain well within the NAAQS. The impacts from the proposed 5-year program on pollutant levels would be minor. Ambient ozone levels are within the Federal standard in all areas of Alaska, so the impacts from the proposed 5-year program activities would be negligible. Air quality impacts from oil spills and in-situ burning could be localized and of short duration and could cause minor impacts on air quality.

2.1.2.3. Impacts on Marine Mammals

Routine operational activities affecting marine mammals include operational discharges and wastes, vessel and aircraft traffic, noise, and structure removal. Predicted impacts to marine mammals from alternative 1 range from negligible to moderate depending on the species. Overall, potential impacts on marine mammals from oil spills could range from negligible to moderate, depending on the time of year, number of individuals contacted by a spill, and the number of spills.

In the Gulf of Mexico, two species of particular concern are the endangered sperm whale and the West Indian manatee. The sperm whale is the only common endangered whale in the Gulf. Generally, impacts from routine operations (e.g., noise associated with seismic surveys, platform removal) and from contact with spilled oil could be minor for sperm whales. The West Indian manatee is usually found in coastal and inshore waters of peninsular Florida, well away from most offshore OCS activities. Because of their distribution, impacts to manatees from routine operations and oil spills is negligible. However, if a spill were to occur and contact them, minor to moderate impacts could result. Five endangered mysticete species (northern right, blue, fin, sei, and humpback whale) also may occur in the Gulf of Mexico. But as all are rare or absent in the Gulf of Mexico, impacts from either routine operations or accidents are negligible. Commonly-sighted cetaceans on the continental shelf include the bottlenose dolphins, pantropical spotted dolphins, Risso's dolphins, and dwarf/pygmy sperm whales. Impacts to these species from routine operations range from negligible (e.g. vessel trips) to minor (explosive structure removals), while impacts from accidents could be minor to moderate.

In Alaska, the main impact factor associated with routine operations that may affect cetaceans is noise associated with prelease and postlease surveys, drilling and production, and decommissioning and abandonment activities. Other impact-producing factors (e.g., operational discharges and wastes and vessel and air traffic) are not expected to produce measurable impacts on cetacean species in Alaska. Impacts to cetaceans from alternative 1 range from negligible to moderate depending on the species. Overall, noise from OCS operations, when forcing an alteration of migratory pathways would produce minor impacts to bowhead whale populations. Routine operations, in particular noise, are expected to have only negligible to minor impacts, typically local avoidance behavior on fin, humpback, blue, sei, and northern right whales due to their low density and sparse distribution throughout the Alaska planning areas. Potential impacts on sperm whales and minke whales due to routine operations are expected to be negligible. Since the populations of Cook Inlet beluga whales are in decline, disturbances, which could reduce fitness, could have minor to moderate impacts on the populations depending on the number of whales affected. Potential impacts on the remainder of the Alaska beluga populations and gray whales caused by noise disturbance from routine operations are expected to be negligible to minor. Potential impacts to killer whales, and harbor and Dall's porpoises are expected to be negligible.

With the exception of the Cook Inlet beluga whale, the impacts to cetaceans from oil spills could range from negligible to moderate depending on the species. Overall, potential impacts on sperm, fin, humpback, blue, sei, or northern right whales from oil spills could range from negligible to moderate, depending on the number of whales contacted by a spill and the number of spills. Potential impacts from oil spills could be negligible to minor for beluga whales in the Beaufort and Chukchi Seas. In general, oil-spill impacts to the Cook Inlet beluga population could be minor, but a possibility for moderate to major impacts exists, given the current decline in the populations. Potential impacts on gray whales and killer whales from oil spills could be minor to moderate. Potential impacts to harbor porpoise and Dall's porpoise could be negligible at the population level.

In Alaska, the Steller sea lion is the only listed pinniped species. Vessel and aircraft traffic are the routine activities that would most likely disturb Steller sea lions. However these OCS support activities could be tailored to avoid critical habitat areas and have only negligible effects on the animals. Potential impacts on the Pacific walrus, ringed seal, bearded seal, spotted seal ribbon seal, and harbor seal from routine operations are expected to be minor. Potential impacts on the northern fur seal are expected to be negligible. Potential impacts to pinnipeds from oil spills could range from minor to major depending on the species affected. Proper mitigation should reduce impacts. If large oil spills were to occur and contact Steller sea lions or their habitat, potential impacts could range from moderate to major depending on the time of the year, location and size of the spill, as well as the number of spills per season. Because of declining populations, effects of oil spills could be major if numerous or large rookeries were contaminated, resulting in high pup and adult mortality. Potential impacts on Pacific walrus and fur seals could range from minor to moderate. Overall, oil spills within the Beaufort and Chukchi Seas could have minor to moderate populations effects on ringed, bearded, spotted, and ribbon seals. Oil spills could have minor to moderate impacts on local populations of harbor seals. Pups are more susceptible to the toxic effects of oil and stress.

Vessel, on-ice vehicle, and aircraft activities have been known to affect polar bear behavior. Polar bears may abandon dens, which could reduce cub survival. On-ice vehicles and ice road construction could have moderate to major effects on denning polar bears; however, mitigation should reduce the level of disturbance. Oil spills could have a minor impact on polar bears through contamination or reduction of prey, fouling of fur, oiling of ice, and temporary abandonment of cleanup areas.

Sea otters appear to habituate to regular human activity, and routine operations would have a negligible impact to their populations. Contact with spilled oil could result in moderate impacts to sea otters.

2.1.2.4. Impacts on Terrestrial Mammals

Routine operations affecting terrestrial mammals include construction and maintenance of onshore infrastructure and pipelines, and support vehicle/vessel traffic. Generally, impacts on Gulf of Mexico terrestrial mammals are predicted to be negligible from routine operations and oil spills. Predicted impacts on Alaskan terrestrial mammals from such activities are minor. Potential impacts on terrestrial mammals from contact with spilled oil could be minor except for the grizzly and black bear, river otter and Sitka black-tailed deer that may experience minor to moderate impacts if contacted occurred with spilled oil.

In the Gulf of Mexico, threatened or endangered terrestrial species include Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice, and the Florida salt marsh vole. The beach mice are limited to mature coastal dune habitats along Alabama and northwest Florida coasts, protected areas buffered from contact with OCS-related infrastructure and contact with spilled oil. The Florida salt marsh vole is found near Cedar Key and would not come into contact with routine OCS operations. Because its habitat is several hundred kilometers from the proposed leasing area within the Eastern Gulf of Mexico Planning Area, it is unlikely to be affected by an oil spill. Potential impacts of routine operations or accidents on listed terrestrial mammals could be negligible.

Routine operations that will directly impact caribou are the construction and maintenance of onshore pipelines and infrastructure. In Alaska four caribou herds, the Western Arctic Herd, Central Arctic Herd, Teshekpuk Lake Herd, and Porcupine Caribou Herd, use habitat adjacent to the Beaufort and Chukchi Sea Planning Areas. Winter construction of onshore infrastructure and pipelines for the proposed action may disturb caribou overwintering near the coast. Some displacement of caribou from development areas, roads, and pipelines will probably occur, particularly during the calving season, but no long-term impacts are expected. Muskox are generally similar to caribou in their response to potential disturbance from OCS exploration and production activities. Muskox are present in the arctic region through the winter, making disturbance from winter construction more likely. However, their limited distribution and smaller population size should greatly restrict impacts. Overall, impacts to caribou and muskox inhabiting the arctic coastal plain will generally be minor. These mammals are selective grazers and would probably not ingest oil vegetation associated with an onshore oil spill contaminating tundra habitat. Direct oiling could result in death from oil absorption and inhalation; cleanup activities could temporarily displace the animals. Impacts to caribou and muskox from accidental spills could be minor.

Arctic foxes are distributed throughout the arctic region of Alaska, using the coastal and offshore habitat in both the Beaufort and Chukchi Sea Planning Areas. Mitigation measures designed to reduce impacts on arctic foxes inhabiting the North Slope oil fields include improved waste management procedures such as eliminating access to landfills, placement of animal-proof garbage dumpsters, and educating oil field personnel on the danger of human/fox contact. Overall, localized oil development and routine operations under the proposed action would have minor impacts on resident arctic fox populations.

In Alaska, the grizzly (brown) bears use the coastal environments and/or terrestrial oil transportation routes onshore of all Alaska planning areas, and black bears make extensive use of coastal areas in Cook Inlet and the Gulf of Alaska. Aircraft traffic may disturb individual bears occasionally for a short period of time. Onshore infrastructure placement could disrupt individual bear dens located near the coast; however, most bears den further inland. Bears may become habituated or attracted to human activities, often leading to conflicts with people. Mitigation measures designed to reduce impacts on North Slope oil field bears include prohibiting firearms and hunting within the developed area, educating oil field personnel about bear safety, training security personnel in proper hazing techniques, eliminating access to the landfill by bears, and installing bear-proof lids on all dumpsters. Impacts of routine operations on grizzly and black bears would be minor. If oil spills were to occur nearshore, contamination of coastal streams, beaches, mudflats, or river mouths could result in food and fur contamination of grizzly or black bears. This could affect some bears and might contribute to a decline in survival of exposed bears, possibly resulting in minor impacts at the population level. In the Cook Inlet area, given the potential seasonal concentrations of bears along the coast during an oil spill, the impacts may be moderate.

In Alaska, river otters can be found using intertidal and subtidal habitats adjacent to the Cook Inlet and the Gulf of Alaska Planning Areas. River otters are highly adaptable and able to shape their individual and social existences around environmental variables, and are able to coexist with human presence and activities. Boat traffic may disturb individual otters for a brief period of time. Overall, routine operations from the proposed action would have negligible impacts on river otter populations. Oil contamination from accidental spills in the otter habitats could contaminate locally important food sources and expose the animal to direct oiling and oil ingestion through grooming and consumption of contaminated prey and oiled carrion. Potential impacts on the Alaskan river otter could be minor to moderate.

Sitka black-tailed deer occur primarily on the islands and mainland along Prince William Sound, the Kodiak Archipelago, and along the Yakutat Bay coast of the Gulf of Alaska Planning Area. Routine operations associated with OCS activities will have negligible, if any, impacts on deer in the area because they are beyond the areas of OCS onshore routine activities. If spilled oil were to reach the Yakutat coast in the Gulf of Alaska from a tanker transportation spill, intertidal vegetation may be contaminated. The combination of oil ingestion with vegetation and hydrocarbon absorption through the skin could increase the winter mortality among deer in the Yakutat area and could result in minor to moderate impacts on the population in the area.

2.1.2.5. Impacts on Marine and Coastal Birds

Routine activities that may affect bird species include infrastructure placement (e.g., pipeline landfalls, gravel island construction), operational discharges and wastes, and vessel and aircraft traffic. Overall, impacts on listed and nonlisted marine and coastal birds from such operations would be minor, with species occurring in the subarctic experiencing negligible to moderate impacts. Generally, impacts on listed marine and coastal birds, if oil spills were to occur and contact birds or their habitat, would be minor to major. Potential impacts on nonlisted marine and coastal birds from oil spills could range from minor to major depending on the size, time of year, and location of the spill.

Species of listed coastal birds using shoreline Gulf of Mexico habitats are the whooping crane, bald eagle, brown pelican, Eskimo curlew, piping plover, and snowy plover. Loss or alteration of preferred habitat due to new OCS pipeline landfalls could result in the displacement and possible decrease in nesting activities. However, impact to coastal habitats is avoided by bringing pipelines to shore through a directional drilling process, and any habitat would recover if disturbed. Impacts from the proposed action to coastal habitats of marine and coastal birds would be minor. Potential impacts to marine and coastal bird species from routine operational discharges under the proposed action may occasionally lead to sublethal stress indirectly (e.g. reduction in prey), or possibly directly through prolonged exposure or the ingestion of affected prey species. However, based on the low concentrations of discharged contaminants within an open-ocean environment, any impact would be negligible. Marine and coastal birds are susceptible to entanglement with discarded debris; however, compliance with regulations will eliminate most impacts. Individual birds may be injured or killed, but impacts to the resource (population) from discarded debris would be minor. Helicopter and service vessel traffic could periodically disturb individuals or groups of listed species of coastal or marine birds. These disturbances would pertain to helicopter or service vessel travel within or across sensitive coastal habitats (e.g., wetlands that may support feeding, resting, or breeding birds) and may cause temporary or permanent displacement of birds. Federal regulations and corporate practices regarding service altitudes for OCS helicopters and vessel speeds when entering or departing coastal waterways are expected to minimize impacts to nesting or roosting birds within coastal areas. Only relatively small proportions of the populations of these species would be exposed, and it is likely that individuals would experience only short-term, minor effects (primarily temporary displacement behavior). If a large spill were to occur in shallow water and reach coastal waters and shorelines, the possibility exists for relatively large numbers of some listed bird species to be affected by contact with the spilled oil in a minor to moderate way. Additionally, oil-spill response activities could cause minor impacts to local populations of shorebirds or wetland birds through short-term behavioral disruption and recoverable damage to coastal habitats.

In Alaska, as most bird species have left the arctic during winter, winter construction activities would not affect seabirds, waterfowl, or shorebirds. However, seabirds and/or waterfowl are present in the subarctic on a year-round basis so impacts to bird populations from oil-field operations would not be restricted to a relatively short summer season, as is the case for the arctic. The impacts of routine operations on threatened Steller's and spectacled eiders, marbled murrelet, and nonlisted species would be similar. A small portion of the world's population of spectacled eiders seasonally occupy the arctic coastal plain. Spectacled eiders nest in wetland habitats along the arctic coastal plain of Alaska, east to near the Canadian border. Ice roads constructed over tundra habitats may cause temporary disturbance to vegetation and could affect tundra-nesting species for only the first year after construction. Such effects may continue until vegetation has completely recovered resulting in minor impacts. Helicopter overflights are generally conducted at low altitudes and can be a major source of noise affecting waterfowl. Molting and staging waterfowl can be temporarily displaced by helicopter overflights. Cormorants, gulls, murres, guillemots, and puffins are colonial nesters in the lower Cook Inlet that could be affected by noise from low flying aircraft. Large seabird nesting colonies in the Barren Islands are far enough from the proposed lease areas that aircraft noise should not pose a significant problem. As helicopter flights are of short duration and aircraft routes could be designed to avoid sensitive areas for seabirds and waterfowl, noise and disturbance effects on birds could be short term and local, having minor effects. Seismic surveys conducted from boats in offshore areas and in lagoon systems could also displace birds from preferred habitats. However, these disturbances would be limited to the immediate area around survey vessels, and negative impacts to waterfowl could be minor.

The arctic peregrine falcons nest inland in foothill areas of the Brooks Range while the American peregrine falcons nest in boreal and temperate forests. Both subspecies are on the Alaska Department of Fish and Game's list of Species of Special Concern. During the summer, arctic peregrines range to coastal areas of the Beaufort Sea where they are an uncommon summer visitor and migrant. Peregrine falcons have nested near pipeline construction projects and have shown the ability to successfully adapt to construction activities. It is expected that routine operations related to oil exploration and production in the arctic planning areas would produce negligible impacts to both peregrine falcon species under the proposed action.

Offshore oil spills present a threat to birds. Waterfowl and seabirds are particularly susceptible to oil spills because they would be the most likely species to come in contact with offshore spills. The survival rate for oiled birds is low. In addition, many marine bird species have low reproductive rates and a slow maturity rate so population recovery from high adult mortality during a large oil spill could take many years, and impacts could be moderate to major depending on the size, location, and timing of the spill.

2.1.2.6. Impacts on Fish Resources

Routine operations that may affect fish resources include installation and removal activities, operational discharges, and exploratory surveying and drilling. Potential impacts from alternative 1 on fish resources from routine operations are predicted to be minor in the Gulf of Mexico OCS Region while ranging from negligible to moderate in the Alaska OCS Region. Potential impacts to fish resources from oil spills are variable and could range from minor to moderate, depending on the size, timing and location of spills. The level of impact also depends on the species and numbers and life stage present. Moderate effects of spills could be on a local level, and fish populations would recover over time.

In the Gulf of Mexico, routine installation activities could temporarily displace or reduce the prey base for adult Gulf sturgeon moving into inner shelf waters of the eastern and central Gulf to feed. Increased turbidity from installation and discharge activities could cause fish to temporarily move from the area. Impacts to nonlisted fish from installation activity are similar to that of the Gulf sturgeon. However, once put in place, platforms serve as artificial reefs or fish attraction devices benefiting those species preferring bottom relief (e.g., snappers, groupers, spadefish). Explosive removals of platforms can kill or stun these fish. However, population-level effects calculated for the red snapper population indicate that the mortality rate associated with platform removal would not add to the mortality estimates already determined for the fished population. Hydrocarbons from spilled oil can affect adult fish by direct contact with gills or via direct ingestion. Planktonic eggs and larvae of nonlisted fishes will die if exposed to certain toxic elements of spilled oil. However, because of the wide dispersal of early life history stages of nonlisted fishes in the surface waters of the Gulf of Mexico, the impacts, if spills were to occur, could be minor. Overall, impacts on Gulf sturgeon and nonlisted fish from routine operations and accidents for the proposed action are predicted to be minor.

Seismic survey airgun discharges can affect pelagic fish species with swim bladders. Acute damage from airgun discharges appears confined to a radius of 1.5 meters (m) from the blast, and the approaching noise source probably scares mobile fishes away before the airgun comes within this range (Turnpenny and Nedwell, 1994). In Alaska, adult and juvenile fish most likely to be affected in the arctic regions include the five species of salmon, the cods (e.g., Walleye pollock found throughout the subarctic areas), cisco, herring, sablefish, and rockfish. Flatfishes (e.g., Pacific halibut) lack swim bladders and would be least impacted by airgun discharges (Yelverton, 1981; Young, 1991). Fish eggs and larvae are more sensitive to injury and mortality from airgun discharges. However, the impact to overall fish population would be negligible since fishes are distributed over wide geographic areas and airgun operations are very localized. Temporary displacement of fishes is the most probable effect of noise generated by seismic surveys, and would be negligible. Turbidity from gravel island and pipeline installation/removal may decrease photosynthesis of plankton, temporarily affecting primary productivity and displacing feeding arctic cod. Turbidity could affect immobile benthic organisms (e.g., through smothering, bioaccumulation of metals and hydrocarbons) which, in turn, could result in minor impacts to demersal fishes and shellfishes (e.g., sablefish, Pacific cod, and crab) that rely on that food source. Artificial islands can moderately affect aquatic organisms by changing local habitat that results in altered local communities. In Alaska, arctic cisco, Dolly Varden, broad whitefish, rainbow smelt, pink salmon, herring, sand lance, eulachon, and capelin are most susceptible to oil spills because they spawn, hatch, and rear in inshore or nearshore areas that could be contaminated following a spill. If a population of these fishes were concentrated in an area during a more vulnerable life stage (i.e., eggs and larva), exposure to a large spill could have major impacts, while adults could experience moderate impacts.

2.1.2.7. Impacts on Turtles

Routine operations associated with the proposed action that may affect turtles include structure placement and removal, operational discharges and wastes, vessel and aircraft traffic, and noise. Overall, impacts to sea turtles from these impact-producing activities are predicted to be minor. If oil spills were to occur and contact sea turtles, impact could be minor to moderate.

Dredging during pipeline trenching and construction of pipeline landfalls can injure or kill sea turtles as well as disrupt their nearshore and coastal habitats. Explosive platform removals can also injure (from pressure effects and noise-related impacts) or kill turtles; however, mitigation measures can reduce any impacts to minor short-term behavioral disturbances. Although operational discharges include components that may injure sea turtles, rapid dilution after discharge and compliance with NPDES permits (that limit concentration of toxic constituents) reduce such impacts. Ingestion of accidentally discarded solid debris may impact sea turtles by affecting the alimentary canal or remaining within the stomach, while entangling with such debris can reduce mobility, drown, and constrict and damage limbs. Noise related to OCS helicopter and vessel traffic is transient and generally not at levels that would prevent rapid recovery of sea turtles once the source was eliminated. Most sea turtles are distributed within waters of the continental shelf, and it is probable that some individuals would come into contact with spilled oil. Direct contact with oil can irritate and inflame sensitive tissues such as eyes and other mucous membranes. Certain species of sea turtles (loggerheads, Kemp's ridley) inhabiting frequently restricted areas such as bays and estuaries may be at greater risk from spilled oil. If a spill were to occur near a nesting beach during the spring and summer nesting season, oil could affect nests and nesting activity.

2.1.2.8. Impacts on Coastal Habitats

Routine operations that could affect coastal habitats include construction of infrastructure such as onshore support bases and pipeline landfalls. Overall, potential impacts to coastal habitats associated with routine operations from the proposed action are predicted to be minor, while impacts could be minor to moderate if oils spills were to occur and contact the coast.

In the Gulf of Mexico, potential impacts on coastal habitats including beaches and dunes, and wetlands from routine operations would be minor. Overall, impacts of oil spills on barrier beaches and dunes would be minor as spilled oil is unlikely to persist on barrier beaches and dunes because they are high-energy habitats. However, if a large oil spill were to reach coastal wetlands in any of the Gulf of Mexico planning areas, there would be a reasonable possibility these resources may not fully recover even if remedial action were taken. However, the overall viability of the wetland resource would not be threatened, and impacts would be minor to moderate.

In Alaska, small areas of coastal habitat will be lost from pipeline landfalls and placement of vertical support members for aboveground, onshore pipelines, onshore bases, and roads. Also, dredging of intertidal habitats for pipeline burial would disturb benthic communities at the site of the trench. The impacts of buried pipelines and pipeline landfalls and related causeways to benthic communities would be localized and minor. Impacts to coastal habitats from the proposed action would be minor from routine operations. If large oil spills were to occur, they could result in minor to moderate impacts, depending on the size, timing, and location of the spills.

2.1.2.9. Impacts on Seafloor Habitats

Routine operations that could affect seafloor habitats include placement and removal of structures, and operational discharges. Overall, impacts from the routine operations associated with the proposed action would be negligible (Gulf of Mexico) to minor (Alaska) and impacts associated with contact from spilled oil could be minor to moderate depending on the size, timing, and location of the spill.

Topographic features or banks in the Western and Central Gulf of Mexico Planning Areas support sensitive hard-bottom species including corals, corraline algae, sponges, and reef fishes. The "Topographic Features" stipulations establishes a no-activity zone in which no operations, anchoring, or structures are allowed, effectively protecting the features/banks and their associated benthic communities from impacts. Live bottom areas are located primarily on the continental shelf offshore west Florida. The pinnacle trend is located along the shelf edge offshore of Mississippi and Alabama Stipulations protect these resources by requiring a bathymetric and video/photographic survey of the bottom. If live bottom communities are present, the lessee must relocate operations, shunt all drilling fluids and cuttings to the bottom or transport them to shore for disposal, or monitor impacts. Most seagrass beds are located off the coast of Florida. Impacts from routine operations are avoided by burying pipelines and avoiding seagrasses in the routing of the pipeline corridors. Chemosynthetic (seep) communities are protected from damage associated with anchoring and placement of structures by siting restriction requirements. If an oil spill were to occur near a seafloor habitat, the biota could be affected. There could be lethal effects to localized areas, but once the feature was clear of oil, the community would recover without mitigation. In most cases, recovery occurs within months to a few years, and any impacts would be minor. Oil reaching seagrass beds would be difficult to clean up and is likely to persist in fine sediments and vegetation, potentially resulting in a minor to moderate impact.

In Alaska, impacts to seafloor habitats and benthic communities from routine operations would be minor for most subtidal benthic communities. However, impacts due to turbidity and sedimentation on the Stefansson Sound Boulder Patch community could range from negligible to moderate depending on the actual location of any proposed development. The Stefansson Sound Boulder Patch is a unique kelp-dominated community only occurring in the central portion of the Beaufort Sea Planning Area. A spill occurring and contacting seafloor habitats and benthic communities could have a minor impact for most subtidal benthic communities, except for the Boulder Patch community where impacts could range from negligible to moderate depending on the size, timing, and location of the spill.

2.1.2.10. Impacts to Essential Fish Habitat (EFH)

Routine activities that may affect EFH include placement and removal of drilling units and production platforms, installation of pipelines, and operational discharges. Overall, impacts on EFH from routine operations associated with the proposed action would be minor. Impacts from oil spills contacting EFH could range from minor to moderate.

Most of the coastal and marine waters of the Gulf of Mexico are considered EFH for life stages of one or more managed species. Sediment disturbance during placement of infrastructure will increase turbidity which, in turn, will lower the water quality of EFH in a small area for a limited amount of time, causing fish to temporarily disperse. Installation of pipelines also disturbs, resuspends and displaces bottom sediments. Associated effects include siltation of seagrass beds which is EFH for specific life stages of managed fish species such as the juvenile yellowtail snapper and post larval and pelagic juvenile gag grouper. Drilling discharges will alter the grain-size distribution and chemical characteristics of sediments around the drill site, which will change the benthic habitat for EFH prey species and spawning sites for red snapper. During platform removal, explosives may injure biota and destroy communities that are prey for managed fish species. Most potential impacts on EFH from accidents would be minor; however, should an oil spill occur and reach submerged seagrass beds or coastal wetlands, more persistent moderate impacts could occur.

In Alaska, sediment disturbance, resuspension, and displacement from routine activities affect EFH in a similar manner as in the Gulf of Mexico. If a large oil spill were to occur, impacts could be as severe as moderate, depending on the size, timing, and location of the spill. Spilled oil reaching wetland habitat, including salt marshes, could kill vegetation and associated inspect species and small fish that are prey species for salmon, potentially adversely affecting EFH.

2.1.2.11. Impacts to National Marine Sanctuaries

Routine activities affecting national marine sanctuaries include placement of structures (e.g., anchoring and pipeline) and operational discharges and wastes. Overall, impacts from routine activities associated with the proposed action are negligible to minor, and impacts from oils spills that contact these resources could be minor.

The Flower Garden Banks National Marine Sanctuary is located offshore Texas and Louisiana. The sanctuary's sensitive coral communities are protected by the Topographic Features Stipulation's "no activity zone" and 4-mile zone that requires shunting of drilling muds and cuttings. Additionally, any anchoring and emplacement of structures are prohibited. Because of the depths of the Flower Garden Banks, if an oil spill were to occur, the biota would probably not be affected by subsurface oil unless that oil came into immediate contact with a bank feature. If immediate contact were to occur, minor impacts could result. The Florida Keys National Marine Sanctuary is located offshore southern Florida, and it is protected by zones with special restrictions to protect its sensitive habitats. No leasing is proposed near the Florida Keys National Marine Sanctuary, so impacts would be negligible.

2.1.2.12. Impacts to National Parks, Reserves, and Refuges

Routine activities affecting parks, reserves, and refuges include placement of structures, pipeline landfalls, operational discharges and wastes, and vessel and aircraft traffic. Overall, impacts from routine activities associated with the proposed action are predicted to be negligible to minor, and impacts from oil spills that contact these resources could be minor to moderate.

Of the national parks located in the Gulf of Mexico, only the Padre Island National Seashore and the Gulf Islands National Seashore are located adjacent to regions in which oil and gas activities could occur under the proposed action. No infrastructure (e.g., pipeline landfalls, shore bases) would be sited in national parks, national wildlife refuges, or national estuarine research reserves. Some OCS-related trash and debris wash up on beaches. Over time, vessel wakes can erode shorelines along inlets, channels, and harbors. However, existing mitigation measures limit vessel speeds in inland waterways and aircraft altitudes over these areas, so impacts would be reduced. If oil spills were to occur, impacts would depend upon the size and specific location of the oil spill and the effectiveness of cleanup procedures. Impacts could include death of wetland vegetation and associated wildlife, oil saturation and trapping by vegetation and sediments, and mechanical destruction of the wetland area during cleanup.

In Alaska, there are seven national parks, monuments, and preserves that could be affected by the proposed action. Onshore oil facilities are permissible only on private acreage within each national parkland. All of the parks, monuments, and preserves contain privately held acreage, but development of onshore facilities in support of offshore oil and gas development is unlikely in many, resulting in negligible impacts. Impacts from accidents could affect these areas of special concern. Impact level depends primarily on the spill location, size, and time of year. Generally, impacts could be minor to moderate. Oil facility development is prohibited on the Arctic National Wildlife Refuge and is discretionary on all other refuges and would be subject to intensive review. Generally, it is unlikely that onshore oil and gas support activities will occur within these refuges, but if they did, impacts would range from negligible to minor. As with parks, impacts to refuges from contact with spilled oil depends on the spill location, size, and time of year. Assuming contact with spilled oil, potential impacts to refugees could range from minor to moderate. Two national forests are found in coastal Alaska. Chugach National Forest is susceptible to routine operations from the transport and tanker loading of oil produced in other regions and transported by pipeline to the Port of Valdez, potentially causing minor impacts from routine operations and minor to moderate impacts from oil spills. No onshore or offshore development will be occurring in the Tongass National Forest area, resulting in negligible impacts from routine operations and minor impacts if an oil spill were to occur.

2.1.2.13. Impacts on Population, Employment, and Regional Income

The main effect of the proposed action on population and employment will be the employment generated by the expected routine OCS oil and gas activity. Overall, potential impacts associated with the proposed action on population, employment, and regional income range from negligible to minor. Oil spills could have negligible (Gulf of Mexico) and minor (Alaska) impacts.

In the Gulf of Mexico OCS Region, based on the exploration and development scenarios, the proposed action is likely to add between 400,000 and 1.3 million person-employment years over a 40-year period. This employment impact is likely to be greatest in the Central Gulf of Mexico and concentrated in New Orleans, Lafayette, and Houma. Even for the areas most affected, however, added employment demands are not likely to tax the local labor market; impacts are predicted to be negligible to minor. The employment impacts of oil spills reaching landfall can vary considerably given the volume of oil reaching land, land area affected, and sensitivity of local environmental conditions. Oil spills could affect such activities as beach recreation, diving, commercial fishing, recreational fishing, and sightseeing. Studies have shown that there could be a one-time seasonal decline in tourist visits associated with a major oil spill; however, tourist movement to other coastal areas in the region often offsets a reduction in the number of visits to one area; the associated loss of business would be very localized. Oil spills could have slight and temporary impacts upon specific local areas. However, at the regional level, these impacts could be considered negligible.

In Alaska, employment and population increases associated with the proposed action would be between 1 and 5 percent. In addition, no sector of the labor force is expected to change by more than 10 percent. Barrow is central for all three arctic subregions, especially the Beaufort Sea subregion that is the center of current oil and gas development. Local employment generated by OCS activity would be less than 5 percent of total Barrow employment and is considered minor. South-central Alaskan communities could be more affected by leasing in their planning area than other parts of Alaska. The larger populations and more diverse economies of south-central Alaskan communities, compared to other Alaskan communities, will tend to dampen the impact of additional leasing on their economies. As a result, local employment generated by OCS activity at its peak is only expected to account for between 1 and 5 percent of the total local employment for 2 to 5 years. The OCS activity will generate indirect and induced employment in Nome, the likely base for marine and air support. The employment generated in Nome at its peak, during production, is expected to be 1-5 percent of the total employment for 2-5 years and will generate associated population increase of less than 5 percent for 2-5 years. Impacts of routine operations in the subarctic region are expected to be minor. Oils spills could generate only temporary employment (and population) increases during cleanup operations, as such operations are expected to be of short duration. Employment generated by spills will be a function of the size and frequency of spills. Impacts from oil spills on population and employment could be minor regionally and moderate locally.

2.1.2.14. Impacts on Land Use and Existing Infrastructure

Routine operations can affect land use and existing infrastructure through construction of petroleum industry support facilities and in-migration. Overall, impacts from routine operations associated with the proposed action on land use and infrastructure onshore range from negligible to moderate. If oil spills were to occur and contact the coast, overall impacts to land use and existing infrastructure could be minor to moderate.

In the Gulf of Mexico Region, the proposed action continues a steady pace of offshore leasing that has persisted in the Gulf of Mexico for more than two decades. This well-established trend is already reflected in most land-use patterns in the Western and Central Gulf of Mexico Planning Areas. Negligible to minor impacts to land usage are predicted by the continuation of leasing and subsequent exploration and development activities in the Western and Central Gulf of Mexico Planning Areas, respectively. Land use in the Eastern Gulf of Mexico Planning Area could be more vulnerable to impact associated with the proposed action; however, the leasing activity in the Eastern Gulf of Mexico Planning Area would be minimal, and no new shore bases, processing facilities, or waste facilities will be required in the eastern Gulf area. Impacts on land-use patterns in this portion of the Gulf of Mexico would be negligible. Some of the labor market areas (LMA's) in the Western and Eastern Gulf of Mexico Planning Areas could exhibit as much as a 2.5-percent net migration change in a single year. High rates of in-migration are invariably followed by compensating rates of out-migration, which tend to return areas to an equilibrium. Under the proposed scenario (alternative 1), some episodic stress on public infrastructure can be expected, as factors external to the coastal LMA's affect local oil and gas activities. The few areas equipped to support deepwater development activities may experience more sustained stress on infrastructure (e.g., Port Fourchon area of coastal Louisiana). Without mediating efforts at infrastructure restoration, the impact in these isolated cases could be moderate, and in the case of Port Fourchon, impacts could be major. Nonetheless, for the great majority of coastal LMA's from Texas to Florida, the impact on infrastructure associated with adoption of the proposed action are predicted to be negligible. Given the current level of existing infrastructure in the Gulf of Mexico Region and the region's history with oil and gas operations (including spill response), impacts to land use and existing infrastructure from oil spills under the proposed action would be minor.

In Alaska, the proposed action would expand existing land-use infrastructure and transportation systems by the construction of support bases, terminals, airfields, pipelines, and roads. Routine operations associated with the proposed action could significantly affect land use in the Beaufort Sea and Chukchi Sea/Hope Basin subregions by building pipelines (subsea and overland), service roads, and new or expanded marine-support facilities, petroleum processing facilities, and airfields. While the Prudhoe Bay complex can provide logistical support for Beaufort Sea OCS exploration and development, no such facilities currently exist for the Chukchi Sea/Hope Basin subregions. In the subarctic, the infrastructure and logistics required to support activity associated with the proposed action are not expected to significantly affect either the infrastructure or land-use patterns of the Nome area, but could significantly affect land use in the Cook Inlet. The community of Nikiski in the Cook Inlet has some existing oil and gas support facilities, but additional elements would likely be needed. Cook Inlet OCS production could be transported via a newly constructed subsea pipeline to the tanker-loading facility near Nikiski. However, both loading and storage capabilities would require expansion to handle the increased volume of produced crude oil. Such land-use changes would be expected to have moderate effects on other user groups and resources (i.e., subsistence, sociocultural systems). One effect under the proposed action would be the construction of petroleum industry facilities in, and increased access to, "new" areas of Alaska (i.e., Chukchi Sea and Hope Basin). This will significantly expand the area potentially at risk from the possible effects of oil spills, along with the requirement to maintain oil-spill response equipment in those areas. Continued OCS development in the Beaufort Sea and Cook Inlet subregions could increase the potential effects of spills in those areas. Impacts of accidents on infrastructure and transportation networks could be moderate.

2.1.2.15. Impacts on Fisheries

Impact factors associated with the proposed action that potentially affect fisheries include structure placement, presence, and removal, and vessel traffic. Overall, potential impacts on commercial and recreational fisheries from routine operations and accidents could be negligible to moderate. Generally impacts from oil spills could be minor to moderate.

Turbidity and noise associated with installation/decommission activities (mobile offshore drilling units, pipelines), deposition of cuttings, and drilling activities could temporarily drive fishes away from the area and preclude fishing. Also such activities would primarily affect soft-bottom species such as red drum, sand sea trout, and spotted sea trout sought by anglers in private or charter/party vessels. Additionally, potential conflicts between exploration activities and fishing gear, bottom trawlers, longliners, and purse netters could also preclude fishing. However, these impacts are temporary. Once platforms are installed and production activities begin, offshore structures will act as fish attraction devices for both pelagic and reef-associated species; these structures would also be attractive to handline fishers. Total area precluded from fishing will vary depending upon the nature of a particular structure or the phase of operation, fishing method, or gear, and target species group. Space-use impacts would be higher for drifting gears such as purse nets, bottom longlines, and pelagic longlines than for trawls and handlines. Nevertheless, areas of preclusion are small relative to the entire fishing area utilized by surface longliners or purse seiners. Federal regulations require that all wellheads, casings, piling, and other obstructions shall be removed. Areas left untrawlable will represent only a fraction of the area excluded by the original oil and gas operation. If oil spills were to occur, commercial fisheries could be affected in several ways. The possibility of oil-soaked fishing gear and potentially contaminated fish may reduce commercial fishing efforts, resulting in economic loss. Individuals of target fish species could be affected directly by exposure to spilled oil, potentially causing fish death or illness. Spills could also indirectly affect commercial fisheries by degrading habitats that are critical for the survival of target species, but could only be serious if they lead to severe declines in target species populations. Adult highly migratory fish species (tunas, sharks and billfish) could move away from surface oil spills in deep water, disrupting fishing efforts.

The single commercial fishery in the Beaufort Sea is for cisco and whitefish on the Colville River during the summer and fall months, and potential impact to that operation from the proposed action would be negligible or minor. There is a small chum salmon fishery in Kotzebue Sound, and the proposed action could have minor impacts on this fishery. Pipelines could affect commercial harvesting of salmon, herring, and other species of finfish in Norton Basin, but pipelines are likely to be buried in all waters of 30 m in depth or less, thereby removing most of the area of potential conflict. Furthermore, the principal types of gear used for the harvesting of finfish in this region (gill nets and seines) are unlikely to suffer damage due to contact with unburied pipelines. Hence, the effects of pipelines on commercial fishing are expected to negligible. Routine activities could interfere with the summer fishery for red king crab, an offshore fishery within Norton Basin, by causing fishing gear loss, loss of ocean fishing space, fishing-vessel collisions, and negative effects from drilling and related activities. However, because of the low level of oil and gas activity expected, such occurrences are expected to be very infrequent. Significant fisheries take place in subarctic regions in Cook Inlet and the Gulf of Alaska. The most significant Cook Inlet fishery is salmon, predominantly sockeye, harvested with drift and set gillnets. The Yakutat fishery is also predominantly a salmon fishery, with the addition of sablefish, halibut, and a limited amount of pollock. Gulf of Alaska fisheries significant for other communities are pollock, cod, and rockfish along with salmon, halibut, and sablefish. Loss of harvest in Cook Inlet due to foreclosure of fishing areas by offshore facilities would be minimal because of the small area occupied by platforms and pipelines. Longline gear conflict is also possible, but could be minimized through a program of mutual communication of activities and avoidance. Such a program would also minimize the potential for longline and pot conflicts with marine seismic surveys. Competition for services and labor would occur largely during exploration and development, given the generally limited marine support services available and the intensive and concentrated nature expected of such OCS activity. This could result in additional costs to the fishing industry for the duration of OCS exploration and development; although once production began, such competition would be reduced (either due to reduced OCS demand or increased supply). Competition for services and labor also would occur during oil-spill response incidents. However, impacts of routine operations are predicted to be minor. No routine exploration and development activities will occur in the Gulf of Alaska because no sales are proposed in that planning area. Therefore, there will be no conflicts with commercial fishing. The occurrence of a tanker spill near commercial fishing areas while fishing is open could affect Gulf of Alaska fisheries. Such a spill could foul gear and potentially close some fishing grounds and could increase competition on alternative fishing grounds that remain open, resulting in increased costs and/or reduced harvests for individual fishermen. Even if harvest continues, the perception of a tainted product can reduce the economic value of fish harvested after an oil spill. The short, intense, local economic spurt often induced by spill response efforts could result in a temporary increase in the cost of support and logistical services due to competition.

2.1.2.16. Impacts on Tourism and Recreation

Impact producing agents associated with routine operations such as helicopter noise, trash and debris, platform placement, pipeline landfall, and vessel traffic could affect tourism and recreational activities. Overall, routine operations associated with the proposed action are predicted to have negligible to moderate impacts on travel, tourism, and recreation. If large oil spills were to occur and contact beaches, they could have minor to moderate impacts on these activities.

In the Gulf of Mexico, primary recreational activities that could be affected include beach recreation, diving, recreational fishing, and sightseeing. Drilling rigs and production platforms are barely visible to major recreation and tourist destination areas like Padre Island National Seashore and Galveston Island in Texas and are not likely to affect use and appreciation of coastal beaches and parks. Most of the platforms and associated drilling operations off Texas, Louisiana, Mississippi, Alabama would occur far from shore and have no direct effects on coastal park and recreation areas. Some tourists and recreation users on coastal beaches along Louisiana, Mississippi, and Alabama would be affected by the sight or sound (helicopter and boat traffic) of OCS oil and gas operations, but few, if any, would forego their visits because of these routine intermittent operations. Pipeline landfalls could cause temporary removal of shoreline recreational land from public use for a period of 2-3 weeks. Pipeline landfalls are likely to cross recreational beaches such as the 65-mile-long Padre Island National Seashore and cause temporary displacement of recreational use of the beach directly affected by pipeline construction. Onshore facilities associated with OCS routine operations most likely would be placed in commercially zoned coastal locations and would not impact recreation or tourism. The proposed action could result in oil contacting the coastal areas from spills from broken pipelines or from platforms in shallow water closer to shore. While oiled beach sediments are usually easily removed via mechanical means, such shoreline activity would effectively close the beach to public use for the duration of cleanup operations. If beach restoration is required (i.e., to restore the proper beach profile), additional time may be required before public access is allowed. Historical evidence pertinent to the effects of major oil spills has indicated that spills may prompt either seasonal declines in tourist visits and/or tourist movement to other coastal areas in the region. Therefore, impacts from spilled oil on tourism and recreational activities and resources along the Gulf coast could vary depending upon the volume of spilled oil, distance from the spill site to shore, the season, and the nature and extent of beach cleanup operations, including the amount of time a beach or coastal waters may be closed.

Recreation and tourism activities along the Alaskan coast consist primarily of water-dependent activities, such as fishing, boating, sightseeing, and associated land-based activities, such as hiking, picnicking, hunting/gathering, and camping. Access is, in many places, restricted to aircraft (floatplane or short-strip wheeled plane) or boat. Routine OCS activities would have only minor effects on recreational opportunities in the arctic region, and may promote some tour activity. The Dalton Highway was constructed to support petroleum development on the North Slope, but it is now a State road; thus, it would be available for future tourism and recreation activities regardless of proposed OCS activities. Most of the potential effects of routine OCS activities on tourism and recreation in Alaska will be felt in the Cook Inlet area. This area is closest to Alaska's centers of population, and has the most developed commercial tourist industry. Anchorage is located at the head of Cook Inlet. The area west of Cook Inlet is roadless. Much of the west coast of the Kenai Peninsula (the eastern shore of Cook Inlet) is accessible by a road that connects a series of various-sized communities, and much of the Kenai Peninsula is relatively undisturbed, with abundant scenery and wildlife. Changes in visual quality would be expected to be local and would be concentrated in periods of high industry activity, such as drilling and laying pipe. The proposed action would add new platforms to those that currently exist in Cook Inlet. Any closure of areas to water-oriented recreational activities would be only for short periods of time. Additional population, crowding, or competition effects due to the proposed OCS activities would be possible, because much of the population and employment increases would occur in the Anchorage/Kenai Peninsula area. Given the relatively small magnitude of these changes in relation to the overall population and economy of that area, however, these effects are expected to be minor. Oil spills could disrupt tourism and recreation in all subregions of Alaska. Oil spills could affect large areas in Cook Inlet and the Gulf of Alaska. In Cook Inlet, an oil spill could foul the beaches on the west side of the Kenai Peninsula and disrupt fishing, sightseeing, and camping for as much as a full season. Many urban Alaskans, as well as visitors from other States, make use of these opportunities and facilities; thus, oil-spill effects in Cook Inlet could be moderate. The pristine character of scenic resources along the Alaskan Peninsula could also be affected for a season if a large spill were to occur, but effects could be minor because the area is so undeveloped. The same evaluation of minor impacts applies to most of the Gulf of Alaska.

2.1.2.17. Impacts on Sociocultural Systems and Environmental Justice

In the Gulf of Mexico, routine operations associated with the proposed action would have negligible to moderate impacts on sociocultural systems; accidents could cause negligible impacts. In Alaska, potential impacts on sociocultural systems are predicted to be minor to moderate, with less significant effects expected in areas already experiencing oil and gas development (i.e., Cook Inlet). Potential impacts from accidents could range from minor to major, depending on the size, location, and timing of a spill. With regards to environmental justice and effects from the proposed action, it is possible that in the Gulf of Mexico and Alaska, new onshore infrastructure supporting the proposed action could be located near minority and low-income populations and could produce adverse health or environmental impacts. If an oil spill were to occur in Alaska waters, the potential environmental and health impacts on Alaska Native populations could be disproportionately high and adverse depending on the geographical location of the spill and associated effects on subsistence resources.

Effects of offshore oil and gas activities on the Gulf of Mexico sociocultural environment are not wholesale regional effects; effects vary from one coastal community to the next. With regards to impacts from the proposed action, sociocultural systems in some communities will experience intense stress (moderate impact) while other communities will have the capacity to weather episodes of rapid industry change and may even thrive in doing so (negligible to minor impact). The environmental justice concerns addressed are mainly in regard to new onshore development related to offshore activities as disproportionately high and adverse human health or environmental effects can only occur onshore. The location of new onshore infrastructure is determined by industry based on economic and logistical considerations and local land-use planning, and is not regulated by the MMS. It is possible that new onshore infrastructure could be located near minority and/or low-income populations. The proposed action scenario includes the addition of new landfalls, shore bases, and waste facilities. Such onshore activity has the potential of creating environmental justice effects. Socioeconomic impacts occurring in supply and fabrication ports along the Gulf of Mexico are likely to have impacts at the community level rather than at a specific minority/low-income group level. Oil spills analyzed in conjunction with in the proposed action could have local, short-term impacts on the natural and socioeconomic environment.

Subsistence activities are extremely important in all parts of rural Alaska and, combined with kinship, comprise the fundamental idiom for describing Native social organization and culture. Fish and marine mammals are the resources of most concern, as they constitute a large part of the harvest and typically are the resources most likely to be affected by OCS activities. Local residents have indicated that whales and other marine mammals are very sensitive to noise and have been disturbed from their normal patterns of behavior by past seismic and drilling activities, thus becoming less predictable and more dangerous to those who hunt them. Offshore pipeline effects on subsistence will be confined to the period of construction and will be mitigated through stipulations, which will minimize industry activities during critical subsistency-use periods. Onshore pipeline effects on subsistence (e.g., perceptions of areas to avoid or which are difficult to access for hunting and trapping) would occur during the construction period and for the operational life of the pipeline. Most Alaskan coastal communities are rural and predominately Native (minority), and many contain at least subpopulations with low incomes. Even in Cook Inlet, several small communities meet the Executive Order 12898 qualifications for consideration under environmental justice. Disproportionately adverse effects on Alaskan Natives could result from the proposed activities in all Alaska planning areas. Based on ethnic composition, any effects from the proposed action for northwest Alaska and the North Slope Borough, or the communities of Tyonek, Port Graham, and Nanwalek in southcentral Alaska will disproportionately affect minority populations. Based on income and poverty measurements, any effects from the proposed action for northwest Alaska, the North Slope Borough, or Tyonek in southcentral Alaska will disproportionately affect populations living in poverty.

2.1.2.18. Impacts on Archaeological Resources

Routine operations associated with the proposed action that may affect archaeological resources include drilling wells, installing platforms, installing pipelines, anchoring, and constructing onshore infrastructure. Existing regulations require that archaeological surveys be conducted prior to permitting any activity that might disturb a significant archaeological site. Compliance with existing regulations will protect archaeological resources from most impacts associated with routine activities; however, some impacts could occur. Overall, impacts on archaeological resources from the proposed action would be minor. Oil spills could affect coastal historic and prehistoric archaeological resources and could result in unavoidable loss of information. The level of this impact depends on the significance and uniqueness of the information lost; the impacts could be minor to moderate.

In the Gulf of Mexico, archaeological resource that could be affected by the proposed action include historic shipwrecks and inundated prehistoric sites offshore, and historic and prehistoric sites onshore. Historic shipwrecks tend to concentrate in the shallow, nearshore waters of the Gulf of Mexico; however, numerous shipwrecks also occur scattered across the continental shelf and even in deepwater areas. Inundated prehistoric sites may exist on the continental shelf shoreward of about the 45-m isobath. Direct physical contact between a routine activity and a shipwreck site could destroy fragile ship remains and could disturb the site context, resulting in a loss of data on ship construction, cargo, and the social organization of the vessel's crew, as well as the concomitant loss of information on maritime culture for the time period from which the ship dates. Ferromagnetic debris associated with OCS operations could mask the magnetic signature of historic archaeological resources, making them difficult to detect with magnetometers. Interaction between a routine activity and a prehistoric archaeological site could destroy artifacts or site features and could disturb the stratigraphic context of the site. Archaeological resource protection during an oil spill requires specific knowledge of the resource's location, condition, nature, and extent prior to impact; however, the Gulf of Mexico coastline has not been systematically surveyed for sites. Existing information indicates that prehistoric sites occur frequently along the barrier islands and mainland coast and the margins of bays and bayous; thus, any spill that contacts these areas could involve a potential impact to a prehistoric site.

In Alaska, archaeological resources that could be affected by the proposed action include historic shipwrecks or aircraft, inundated prehistoric sites offshore, and historic and prehistoric sites onshore. Archaeological sites along the present shoreline, in shallow nearshore waters and along shallow bathymetric highs, have a high likelihood of having already been severely impacted by ice gouging. Shipwrecks in deeper water, beyond the areas of severe ice gouging (in the deeper waters off Point Barrow), have a chance of survival. Likewise, prehistoric archaeological sites that have been buried by a sufficient amount of sediment may be protected from the effects of ice gouging, winter storms, and current scour. Impacts from routine operations are similar to those that could occur to historic and prehistoric sites in the Gulf of Mexico Region. Archaeological resources are particularly abundant along the Gulf of Alaska shorelines, and some type of archaeological resource is present on or adjacent to nearly all Alaska shorelines. Gross crude oil contamination of shorelines is a potential impact that could affect archaeological site recognition. Cleanup activities could impact beached shipwrecks, or shipwrecks in shallow waters, and coastal historic and prehistoric archaeological sites. Unauthorized collecting of artifacts by cleanup crews is also a concern.

2.2. Alternative 2—Slow the Pace of Leasing

2.2.1. Description

Alternative 2—Slow the Pace of Leasing would hold 16 or 17 sales in eight OCS planning areas (Tables 4-2a and b):

- Central Gulf of Mexico—5 annual sales
- Western Gulf of Mexico—5 annual sales

- Eastern Gulf of Mexico—1 sale
- Beaufort Sea—1 or 2 sales
- Chukchi Sea—1 sale
- Hope Basin—1 sale
- Cook Inlet—1 sale
- Norton Basin—1 sale

There would be one sale rather than two in the Eastern Gulf of Mexico Planning Area, one or two sales rather than three in the Beaufort Sea Planning Area, and one sale rather than two in the Chukchi Sea/Hope Basin and Cook Inlet Planning Areas. Annual sales would continue to be held in the Central and Western Gulf of Mexico Planning Areas. This alternative assumes an identical means of transporting hydrocarbons to shore from production facilities in the Eastern Gulf of Mexico, Beaufort Sea, Chukchi Sea, Hope Basin, and Cook Inlet, as with alternative 1. However, some of the oil and gas that would not be produced under this alternative would be replaced by foreign oil imported by tankers.

2.2.2. Comparison of Impacts

As a result of fewer lease sales, the amount of hydrocarbons anticipated to be produced under alternative 2 would be less than under the proposed action for the Eastern Gulf of Mexico, Beaufort Sea, Chukchi Sea, Hope Basin, and Cook Inlet Planning Areas. As well, offshore and onshore oil and gas activities associated with these areas would be lower. Table 4-2c presents the number of oil spills assumed to occur and the probability of spill occurrence as a result of OCS activity associated with alternative 2. It is assumed that spills would occur with uniform frequency over the life of the OCS activities and that the number of spills from import tankers would increase somewhat in the Gulf of Mexico and on the west coast because of the increased amount of imported oil.

In the Gulf of Mexico, slowing the pace of leasing will reduce the number of sales in the Eastern Gulf of Mexico Planning Area from two to one. It is estimated that the slower pace of leasing would result in the production of approximately half of the oil and gas resources estimated to be produced if two sales were conducted (alternative 1). There would be a corresponding reduction in the level of exploration, development, and production activity. However, there would be no change in the Central and Western Gulf of Mexico Planning Areas where sales would be held annually.

In the Alaska Region, slowing the pace of leasing will reduce the number of sales in the Beaufort Sea from three to one or two, and in the Chukchi Sea/Hope Basin and Cook Inlet from two to one. It is estimated that alternative 2 would result in the production of approximately 33-66 percent of the oil resources estimated to be produced in the Beaufort Sea and approximately half the hydrocarbon resources estimated to be produced in the Chukchi Sea, Hope Basin, and Cook Inlet. There would be a corresponding reduction in the level of exploration, development, and production activity. Fewer large spills would occur in the Beaufort Sea, Chukchi Sea, and Cook Inlet if alternative 2 were adopted. The number of sales in Norton Basin would remain the same, resulting in no change in associated anticipated oil and gas activity.

Slowing the pace of leasing would reduce the associated oil-spill risk slightly. However, the number of spills that would occur from tankers carrying OCS-produced oil from Valdez to west coast ports under alternative 2 is likely to be the same as the proposal. Therefore, adoption of this alternative could result in impacts to environmental resources in the Pacific Region similar to impacts from the proposal. Because less oil would be produced in the Alaska Region and transported to west coast ports if this alternative were adopted, the likelihood of these impacts occurring is slightly reduced.

Alternative 2 would result in somewhat reduced impacts locally for the following resources, but overall, the impact level is expected to be the same as for alternative 1:

- water quality
- terrestrial mammals
- fish resources (Gulf of Mexico)
- coastal habitats (Alaska)
- seafloor habitats
- essential fish habitat
- national parks, refuges, and forests (Alaska)
- demography, employment, and regional income
- commercial and recreational fisheries (Gulf of Mexico)
- land use and infrastructure (Alaska)
- tourism and recreation (Alaska)
- archaeological resources

A summary of the environmental impacts of alternatives 1 and 2 are presented below in comparative form.

RESOURCE	ALTERNATIVE 1	ALTERNATIVE 2
Water Quality	Gulf of Mexico - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills. Alaska - **Negligible** to **minor** from routine activities. - **Minor** to **moderate** from large oil spills.	Gulf of Mexico - **Minor** from routine activities regionally. - **Minor** to **moderate** from large oil spills in Central and Western Gulf; somewhat less in Eastern Gulf. Alaska - **Negligible** to **minor** from routine activities regionally; somewhat less locally. - **Minor** to **moderate** from large oil spills regionally; somewhat less locally.
Air Quality	Gulf of Mexico - **Minor** from routine activities. - **Minor** from large oil spills. Alaska - **Minor** from routine activities. - **Minor** from large oil spills.	Gulf of Mexico - **Minor** from routine activities. - **Minor** from large oil spills. Alaska - **Minor** from routine activities. - **Minor** from large oil spills.
Marine Mammals	Gulf of Mexico Manatee - **Negligible** from routine activities. All Others - **Minor** from routine activities. Manatee - **Minor** to **moderate** from large spills. Sperm Whale - **Minor** from large spills. All Others - **Minor** to **moderate** from large spills.	Gulf of Mexico Manatee - **Negligible** from routine activities. All Others - **Minor** from routine activities. Manatee - **Minor** to **moderate** from large spills. Sperm Whale - **Minor** from large spills. All Others - **Minor** to **moderate** from large spills.

RESOURCE	ALTERNATIVE 1	ALTERNATIVE 2
Marine Mammals (continued)	Alaska Bowhead and Cook Inlet Beluga Whales - **Minor** to **moderate** from routine activities. - **Minor** to **major** from large oil spills. Other Cetaceans - **Negligible** to **minor** from routine activities. - **Negligible** to **moderate** from large oil spills. Pinnipeds - **Negligible** to **minor** from routine activities. - **Minor** to **major** from large oil spills. Polar Bears - **Minor to moderate** from routine activities. - **Minor** from large oil spills. Sea Otters - **Negligible** from routine activities. - **Moderate** from large oil spills.	Alaska Bowhead and Cook Inlet Beluga Whales - **Minor to moderate** from routine activities. - **Minor** to **major** from large oil spills. Other Cetaceans - **Negligible to minor** from routine activities. - **Negligible** to **moderate** from large oil spills. Pinnipeds - **Negligible** to **minor** from routine activities. - **Minor to major** from large oil spills. Polar Bears - **Minor** to **moderate** from routine activities. - **Minor** from large oil spills. Sea Otters - **Negligible** from routine activities. - **Moderate from** large oil spills.
Terrestrial Mammals	Gulf of Mexico - **Negligible** from routine activities and large spills. Alaska Grizzly Bear, Black Bear, River Otter, Sitka Black-Tailed Deer - **Negligible** to **minor** from routine activities. - **Minor** to **moderate** from large oil spills. Caribou, Muskox, Arctic Fox - **Minor** from routine activities and large spills.	Gulf of Mexico - **Negligible** from routine activities and large spills regionally; somewhat less in Eastern Gulf. Alaska Grizzly Bear, Black Bear River Otter, Sitka Black-Tailed Deer - **Negligible** to **minor** from routing activities. - **Minor** to **moderate** from large spills regionally; somewhat less locally. Caribou, Muskox, Arctic Fox, - **Minor** from routine activities and large spills regionally; somewhat less locally.
Marine and Coastal Birds	Gulf of Mexico - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills. Alaska Listed and Nonlisted Birds (arctic) - **Negligible** to **minor** from routine activities Nonlisted Birds (subarctic) - **Negligible** to **moderate** from routine activities Listed and Nonlisted Birds (arctic and subarctic) - **Minor** to **major** from large oil spills.	Gulf of Mexico - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills. Alaska Listed and Nonlisted Birds (arctic) - **Negligible** to **minor** from routine activities Nonlisted Birds (subarctic) - **Negligible** to **moderate** from routine activities Listed and Nonlisted Birds (arctic and subarctic) - **Minor** to **major** from large oil spills.
Fish Resources	Gulf of Mexico - **Minor** from routine activities and oil spills. Alaska - **Negligible** to **moderate** from routine activities. - **Minor** to **moderate** from large oil spills.	Gulf of Mexico - **Minor** from routine activities and spills regionally; somewhat less in EGOM. Alaska - **Negligible** to **moderate** from routine activities regionally; somewhat less locally. - **Minor** to **moderate** from large spills regionally; somewhat less locally.
Sea Turtles	Gulf of Mexico - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills.	Gulf of Mexico - **Minor** to **moderate** from routine activities and oil spills regionally; somewhat less in the EGOM.

RESOURCE	ALTERNATIVE 1	ALTERNATIVE 2
Coastal Habitats	Gulf of Mexico Beaches and Dunes - **Minor from** routine activities and large spills. Wetlands - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills. Alaska - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills.	Gulf of Mexico Beaches and Dunes - **Minor** from routine activities and large spills. Wetlands - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills. Alaska - **Minor** to **moderate** from routine activities and oil spills regionally; somewhat less locally.
Seafloor Habitats	Gulf of Mexico Topographic Features - **Negligible** from routine activities. - **Minor from** oil spills. Live Bottoms and Pinnacles - **Minor** from routine activities and large spills. Seagrass Beds - **Minor** from routine activities. - **Minor to moderate** from large oil spills. Chemosynthetic Communities - **Minor** from routine activities and large spills. Alaska Stefansson Sound Boulder Patch - **Negligible** to **moderate** from routine activities and large oil spills. Other Seafloor Habitats - **Minor** from **routine** activities and large spills.	Gulf of Mexico Topographic Features - **Negligible from** routine activities. - **Minor** from oil spills regionally; somewhat less in Eastern Gulf. Live Bottoms and Pinnacles - **Minor from** routine activities and oil spills regionally; somewhat less in the Eastern Gulf. Seagrass Beds - **Minor from** routine activities regionally; somewhat less in the Eastern Gulf. - **Moderate** from large oil spills; somewhat less in the Eastern Gulf. Chemosynthetic Communities - **Minor from** routine activities and large spills. Alaska Stefansson Sound Boulder Patch - **Negligible** to **moderate** from routine activities and large oil spills. Other Seafloor Habitats - **Minor from** routine activities and large spills regionally; somewhat less locally.
Areas of Special Concern	Gulf of Mexico Parks, Refuges, and Reserves - **Negligible** to **minor** from routine activities. - **Minor to moderate** from large oil spills. Flower Garden Banks - **Negligible** from routine activities. - **Minor** from large oil spills. Florida Keys Marine Sanctuary - **Negligible** from routine activities and large spills. Alaska Essential Fish Habitat - **Minor** from routine activities. - **Moderate** from large oil spills. Parks - **Negligible** from routine activities. - **Negligible** to **moderate** from large oil spills. Refuges and Forests - **Negligible** to **minor** from routine activities. - **Minor** to **moderate** from large oil spills.	Gulf of Mexico Parks, Refuges, and Reserves - **Negligible to minor** from routine activities. - **Minor** to **moderate** from large oil spills. Flower Garden Banks - **Negligible** from routine activities. - **Minor** from large oil spills. Florida Keys Marine Sanctuary - **Negligible** from routine activities and large spills. Alaska Essential Fish Habitat - **Minor** from routine activities regionally; somewhat less locally. - **Moderate** from large oil spills regionally; somewhat less locally. Parks - **Negligible** from routine activities regionally, somewhat less locally. - **Negligible** to **moderate** from large spills regionally, less locally. Refuges and Forests - **Negligible** to **minor** from routine activities. - **Minor** to **moderate** from large oil spills, except **negligible** to **minor** for ANWR.

RESOURCE	ALTERNATIVE 1	ALTERNATIVE 2
Population, Employment, and Regional Income	Gulf of Mexico - **Negligible** to **minor** from routine activities. - **Negligible** from large oil spills. Alaska - **Minor** from routine activities and large oil spills; **moderate** locally from large oil spills.	Gulf of Mexico - **Negligible** to **minor** from routine activities regionally, somewhat less in Florida. - **Negligible** from large oil spills regionally; somewhat less in Florida. Alaska - **Minor** from routine activities and large oil spills regionally; **moderate** locally from large oil spills; somewhat less locally from routine activities.
Land Use and Infrastructure	Gulf of Mexico - **Negligible** to **moderate** from routine activities. - **Major** for Port Fourchon. - **Minor** from large oil spills. Alaska - **Moderate** from routine activities. - **Minor** to **moderate** from large oil spills.	Gulf of Mexico - **Negligible** to **moderate** from routine activities. - **Major** for Port Fourchon. - **Minor** from large oil spills. Alaska - **Moderate** from routine activities regionally; somewhat less locally. - **Minor** to **moderate** from large oil spills.
Fisheries	Gulf of Mexico - **Minor** to **moderate** from routine activities. - **Minor** from large oil spills. Alaska Gulf of Alaska - **Negligible** to **minor** from routine activities. - **Minor** to **moderate** from large oil spills. Bering Sea - **Negligible** to **minor** from routine activities. - **Negligible** from large oil spills.	Gulf of Mexico - **Minor** to **moderate** from routine activities regionally; somewhat less in Eastern Gulf. - **Minor** from large oil spills regionally; slightly less in Eastern Gulf. Alaska Gulf of Alaska - **Negligible** to **minor** from routine activities; somewhat less locally. - **Minor** to **moderate** from large oil spills regionally; somewhat less locally Bering Sea - **Negligible** to **minor** from routine activities regionally; somewhat less locally. - **Negligible** from large oil spills regionally; somewhat less locally.
Tourism and Recreation	Gulf of Mexico - **Negligible** from routine activities. - **Minor** to **moderate** from large oil spills. Alaska - **Minor** to **Moderate** from routine activities and large oil spills.	Gulf of Mexico - **Negligible** from routine activities. - **Minor** to **moderate** from large oil spills. Alaska - **Minor** to **Moderate** from routine activities and large oil spills; somewhat less locally.
Sociocultural Systems and Environmental Justice	Gulf of Mexico Sociocultural Systems - **Negligible** to **moderate** from routine activities. - **Negligible** from **large** oil spills. Alaska Sociocultural Systems - **Minor** to **moderate** from routine activities. - **Minor** to **major** from large oil spills. Environmental Justice - **Disproportionately high** impacts from large oil spills.	Gulf of Mexico Sociocultural Systems - **Negligible** to **moderate** from routine activities. - **Negligible** from large oil spills. Alaska Sociocultural Systems - **Minor** to **moderate** from routine activities regionally; somewhat less locally. - **Minor** to **major** from large oil spills regionally; somewhat less locally. Environmental Justice - **Disproportionately high** impacts from large oil spills.

RESOURCE	ALTERNATIVE 1	ALTERNATIVE 2
Archaeological Resources	Gulf of Mexico - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills. Alaska - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills.	Gulf of Mexico - **Minor** from routine activities regionally; somewhat less in Eastern Gulf. - **Minor** to **moderate** from large oil spills regionally; somewhat less in Eastern Gulf. Alaska - **Minor** from routine activities regionally; somewhat less locally. - **Minor** to **moderate** from large oil spills regionally; somewhat less locally.

Note: Impact levels for oil spills are based on the assumption that one or more large oil spills occur and contact the resource.

2.3 Alternative 3—Exclude Some Planning Areas

2.3.1. Description

Alternative 3 would hold 17 sales in five planning areas (Tables 4-3a and b):

- Central Gulf of Mexico—5 annual sales
- Western Gulf of Mexico—5 annual sales
- Beaufort Sea—3 sales
- Chukchi Sea—2 sales
- Cook Inlet—2 sales

Under alternative 3, no sales would be held in the Eastern Gulf of Mexico, Norton Basin, or Hope Basin Planning Areas. There would be no change from alternative 1 in the remaining areas: annual sales would be held in the Central and Western Gulf of Mexico Planning Areas, 3 sales would be held in the Beaufort Sea, 2 sales would be held in Chukchi, and 2 sales would be held in Cook Inlet. The same means of transporting hydrocarbons to shore from production facilities would be used in all planning areas for alternatives 1 and 3. Some of the oil and gas that would not be produced in the Eastern Gulf of Mexico, if alternative 3 were adopted, would be replaced by foreign oil imported by tankers.

2.3.2. Comparison of Impacts

Under alternative 3, no oil or gas would be produced from the Eastern Gulf of Mexico, Norton Basin, and Hope Basin Planning Areas; therefore, there would be no offshore or onshore oil and gas activities in these three planning areas as a result of the proposed program. The estimated oil and gas resources and associated activities would be the same for this alternative as for alternative 1 in the Central and Western Gulf of Mexico, the Beaufort Sea, Chukchi Sea, and Cook Inlet. No oil was expected to be produced in either the Norton Basin or Hope Basin Planning Areas during the life of the proposed program so eliminating sales in these planning areas would have no effect on foreign imports. It is assumed that oil spills would occur with uniform frequency over the life of the OCS activities resulting from this alternative.

In the Gulf of Mexico, there will be no sales in the Eastern Gulf of Mexico and annual sales in the Central and Western Gulf of Mexico Planning Areas if alternative 3 is adopted. Some impacts could still occur in the Eastern Gulf of Mexico from oil and gas activities in the Central Gulf. Impacts to coastal resources in Florida are much less likely, however, because of the distance from any offshore activities from the proposed program.

In Alaska under alternative 3, no sales in the Hope Basin or Norton Basin would be held and leasing would be restricted to the Beaufort Sea, Chukchi Sea, and Cook Inlet Planning Areas. The anticipated oil and gas activity in those three planning areas would be the same as for alternative 1. None of the impacts predicted for alternative 1 as a result of sales conducted in Hope Basin or Norton Basin would occur if alternative 3 were adopted.

The only threat to resources along the Pacific coast from the proposed program would be from the transportation of OCS oil from the port of Valdez to west coast ports. However, all the OCS oil estimated to be transported to Valdez through TAPS would originate in the Beaufort and Chukchi Seas. As a result, if alternative 3 were adopted, it is assumed that the amount of OCS oil transported from Valdez and the number of spills that would occur from tankers carrying that oil to west coast ports, would be the same as the proposal. Therefore, adoption of this alternative could result in impacts to environmental resources in the Pacific Region similar to impacts from the proposal.

Generally, alternative 3 would result in reduced local impacts to resources in those planning areas excluded from leasing, but its overall impact level for the resources analyzed in the EIS is expected to be the same as for alternative 1.

A summary of the environmental impacts of alternatives 1 and 3 is presented below in comparative form.

RESOURCE	ALTERNATIVE 1	ALTERNATIVE 3
Water Quality	Gulf of Mexico - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills. Alaska - **Negligible** to **minor** from routine activities. - **Minor** to **moderate** from large oil spills.	Gulf of Mexico - **Minor** from routine activities regionally. - **Minor** to **moderate** from large oil spills in Central and Western Gulf; **negligible** in Eastern Gulf. Alaska - **Negligible** to **minor** from routine activities regionally; less in Hope and Norton areas. - **Minor** to **moderate** from large oil spills regionally; **negligible** in Hope; none in Norton.
Air Quality	Gulf of Mexico - **Minor** from routine activities. - **Minor** from large oil spills. Alaska - **Minor** from routine activities. - **Minor** from large oil spills.	Gulf of Mexico - **Minor** from routine activities; less in Alabama and Florida. - **Minor** from large oil spills. Alaska - **Minor** from routine activities regionally; less in Hope and Norton areas. - **Minor** from large oil spills regionally; **negligible** in Hope; none in Norton.

RESOURCE	ALTERNATIVE 1	ALTERNATIVE 3
Marine Mammals	Gulf of Mexico Manatee - **Negligible** from routine activities. All Others - **Minor** from routine activities. Manatee - **Minor** to **moderate** from large spills. Sperm whale - **Minor** from large spills. All Others - **Minor** to **moderate** from large spills. Alaska Bowhead and Cook Inlet Beluga Whales - **Minor** to **moderate** from routine activities. Other Cetaceans - **Negligible** to **minor** from routine activities. Cook Inlet Beluga Whales - **Minor** to **major** from large oil spills. Other Cetaceans - **Negligible** to **moderate** from large oil spills. Pinnipeds - **Negligible** to **minor** from routine activities. - **Minor** to **major** from large oil spills. Polar Bears - **Minor** to **moderate** from routine activities. - **Minor** from large oil spills. Sea Otters - **Negligible** from routine activities. - **Moderate** from large oil spills.	Gulf of Mexico Manatee - **Negligible** from routine activities. All Others - **Minor** from routine activities. Manatee - **Negligible** from large spills. Sperm whale - **Minor** from large spills. All Others - **Minor** to **moderate** from large spills; somewhat less offshore Florida. Alaska Bowhead and Cook Inlet Beluga Whales - **Minor** to **moderate** from routine activities. Other Cetaceans - **Negligible** to **minor** from routine activities regionally; none in Hope or Norton Basins. Cook Inlet Beluga Whales - **Minor** to **major** from large oil spills. Other Cetaceans - **Negligible** to **moderate** from large oil spills regionally; **negligible** in Hope; none in Norton. Pinnipeds - **Negligible** to **minor** from routine activities regionally; none in Hope or Norton Basins. - **Minor** to **major** from large oil spills regionally; none in Hope or Norton Basins. Polar Bears - **Minor to moderate** from routine activities. - **Minor from** large oil spills. Sea Otters - **Negligible** from routine activities. - **Moderate** from large oil spills.
Terrestrial Mammals	Gulf of Mexico - **Negligible** from routine activities and large spills. Alaska Grizzly Bear, Black Bear, River Otter, Sitka Black-Tailed Deer - **Negligible** to **minor** from routine activities. - **Minor** to **moderate** from large oil spills. Caribou, Muskox, Arctic Fox, - **Minor** from routine activities and large spills.	Gulf of Mexico - **Negligible** from routine activities and large spills. Alaska Grizzly Bear, Black Bear; River Otter and Sitka Black-Tailed Deer - **Negligible** to **minor** from routing activities regionally; somewhat less in Hope and Norton Basins. - **Minor** to **moderate** from large spills regionally; none in Hope or Norton Basins. Caribou, Muskox, Arctic Fox, - **Minor** from routine activities and large spills regionally; none in Hope and Norton Basins.
Marine and Coastal Birds	Gulf of Mexico - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills.	Gulf of Mexico - **Minor** from routine activities; **negligible** in Eastern Gulf. - **Minor** to **moderate** from large oil spills; **negligible** in Eastern Gulf.

RESOURCE	ALTERNATIVE 1	ALTERNATIVE 3
Marine and Coastal Birds (continued)	Alaska Listed and Nonlisted Birds (arctic) - **Negligible** to **minor** from routine activities Nonlisted Birds (subarctic) - **Negligible** to **moderate** from routine activities Listed and Nonlisted Birds (arctic and subarctic) - **Minor** to **major** from large oil spills	Alaska Listed and Nonlisted Birds (arctic) - **Negligible** to **minor** from routine activities regionally; none in Hope Basin. Nonlisted Birds (subarctic) - **Negligible** to **moderate** from routine activities, none in Norton Basin. Listed and Nonlisted Birds (arctic and subarctic) - **Minor** to **major** from large oil spills regionally; none in Hope or Norton Basins.
Fish Resources	Gulf of Mexico - **Minor** from routine activities and oil spills. Alaska - **Negligible** to **moderate** from routine activities. - **Minor** to **moderate** from large oil spills.	Gulf of Mexico - **Minor** from routine activities and spills regionally; **negligible** in Eastern Gulf. Alaska - **Negligible** to **moderate** from routine activities regionally; none in Hope or Norton Basins. - **Minor** to **moderate** from large spills regionally; **negligible** in Hope; none in Norton.
Sea Turtles	Gulf of Mexico - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills.	Gulf of Mexico - **Minor** routine activities regionally; **negligible** in Eastern Gulf. - **Minor** to **moderate** from large spills regionally; **negligible** in Eastern Gulf.
Coastal Habitats	Gulf of Mexico Beaches and Dunes - **Minor** from **routine** activities. - **Minor** from large oil spills. Wetlands - **Minor** to **moderate** from routine activities. - **Minor** from large oil spills. Alaska **Minor** from routine activities. **Minor** to **moderate** from large oil spills.	Gulf of Mexico Beaches and Dunes - **Minor** from **routine** activities regionally; less in EGOM. - **Minor** from large oil spills regionally; **negligible** in Eastern Gulf. Wetlands - **Minor to moderate** from routine activities regionally; less in Eastern Gulf. - **Minor** from large oil spills regionally; **negligible** in Eastern Gulf. Alaska **Minor** from routine activities regionally; none in Hope and Norton Basins. **Minor** to **moderate** from large spills regionally; none in Hope or Norton Basins.
Seafloor Habitats	Gulf of Mexico Topographic Features - **Negligible** from **routine** activities. - **Minor** from **oil** spills. Live Bottoms and Pinnacles - **Minor** from routine activities. - **Minor** from large oil spills. Seagrass Beds - **Minor** from **routine** activities. - **Moderate** from large oil spills. Chemosynthetic Communities - **Minor** from routine activities. - **Minor** from large oil spills.	Gulf of Mexico Topographic Features - **Negligible from** routine activities. - **Minor** from oil spills. Live Bottoms and Pinnacles - **Minor from** routine activities and oil spills, **Negligible** in the Eastern Gulf. Seagrass Beds - **Minor from** routine activities, except **negligible** in the Eastern Gulf. - **Moderate** from large oil spills, **negligible** in the Eastern Gulf. Chemosynthetic Communities - **Minor** from routine activities. - **Minor** from **large** oil spills.

RESOURCE	ALTERNATIVE 1	ALTERNATIVE 3
Seafloor Habitats (continued)	Alaska Stefansson Sound Boulder Patch - **Negligible** to **moderate** from routine activities and large oil spills. Other Seafloor Habitats - **Minor** from routine activities and large spills.	Alaska Stefansson Sound Boulder Patch - **Negligible** to **moderate** from routine activities and large oil spills. Other Seafloor Habitats - **Minor** from routine activities and large oil spills regionally; none in Hope or Norton basins.
Areas of Special Concern	Gulf of Mexico Parks, Refuges, and Reserves - **Negligible** to **minor** from routine activities. - **Minor** to **moderate** from large oil spills. Flower Garden Banks - **Negligible** from routine activities. - **Minor** from large oil spills. Florida Keys Marine Sanctuary - **Negligible** from routine activities and large spills. Alaska EFH - **Minor** from routine activities. - **Moderate** from large oil spills. Parks - **Negligible** from routine activities. - **Negligible** to **moderate** from large oil spills. Refuges and Forests - **Negligible** to **minor** from routine activities. - **Minor** to **moderate** from large oil spills.	Gulf of Mexico Parks, Refuges, and Reserves - **Negligible** to **minor** from routine activities; **negligible** for coastal sites in Eastern Gulf. - **Minor** to **moderate** from large oil spills; **negligible** for coastal sites in Eastern Gulf. Flower Garden Banks - **Negligible** from routine activities. - **Minor** from large oil spills. Florida Keys Marine Sanctuary -No impacts from routine activities or large oil spills. Alaska EFH - **Minor** from routine activities regionally; none in Hope or Norton Basins. - **Moderate** from large oil spills regionally; none in Hope or Norton Basins. Parks - **Negligible** from routine activities regionally, none in Hope or Norton Basins. - **Negligible** to **moderate** from large spills regionally; none in Hope or Norton Basins. Refuges and Forests - **Negligible** to **minor** from routine activities regionally; none in Hope or Norton Basins. - **Minor** to **moderate** from large spills regionally, none in Hope or Norton Basins.
Population, Employment, and Regional Income	Gulf of Mexico - **Negligible** to **minor** from routine activities. - **Negligible** from large oil spills. Alaska - **Minor** from routine activities and large oil spills; **moderate** locally from large oil spills.	Gulf of Mexico - **Negligible** to **minor** from routine activities regionally; somewhat lower in the Eastern Gulf. - **Negligible** from large oil spills. Alaska - **Minor** from routine activities and large oil spills regionally; **moderate** locally from large oil spills; none in Hope and Norton Basins.
Land Use and Infrastructure	Gulf of Mexico - **Negligible** to **moderate** from routine activities. - **Major** for Port Fourchon. - **Minor** from large oil spills. Alaska - **Moderate** from routine activities. - **Minor** to **moderate** from large oil spills.	Gulf of Mexico - **Negligible** to **moderate** from routine activities. - **Major** for Port Fourchon. - **Minor** from large oil spills. Alaska - **Moderate** from routine activities regionally; none in Hope and Norton Basins. - **Minor** to **moderate** from large oil spills, none in Hope and Norton Basins.

RESOURCE	ALTERNATIVE 1	ALTERNATIVE 3
Fisheries	Gulf of Mexico - **Minor** to **moderate** from routine activities. - **Minor** from large oil spills. Alaska Gulf of Alaska - **Negligible** to **minor** from routine activities. - **Minor** to **moderate** from large oil spills Bering Sea - **Negligible** to **minor** from routine activities. - **Negligible** from large oil spills.	Gulf of Mexico - **Minor** to **moderate** from routine activities; lower in the Eastern Gulf. - **Minor** from large oil spills; slightly lower in the Eastern Gulf. Alaska Gulf of Alaska - **Negligible** to **minor** from routine activities. - **Minor** to **moderate** from large oil spills Bering Sea - **None**.
Tourism and Recreation	Gulf of Mexico - **Negligible** from routine activities. - **Minor** to **moderate** from large oil spills. Alaska - **Minor** to **moderate** from routine activities and large spills.	Gulf of Mexico - **Negligible** from routine activities. - **Minor** to **moderate** from large oil spills. Alaska - **Minor** to **moderate** regionally; none in Hope or Norton Basins.
Sociocultural Systems and Environmental Justice	Gulf of Mexico Sociocultural Systems - **Negligible** to **moderate** from routine activities. - **Negligible** from large oil spills. Environmental Justice - **No impacts** identified**.** Alaska Sociocultural Systems - **Minor** to **moderate** from routine activities. - **Minor** to **major** from large oil spills. Environmental Justice - **Disproportionately high** impacts from large spills.	Gulf of Mexico Sociocultural Systems - **Negligible** to **moderate** from routine activities. - **Negligible** from large oil spills. Environmental Justice - **No impacts** identified**.** Alaska Sociocultural Systems - **Minor** to **moderate** from routine activities regionally; none in Hope or Norton Basins. - **Minor** to **major** from large oil spills, none in Hope or Norton Basins. Environmental Justice - **Disproportionately high** impacts regionally; none in Hope or Norton Basins.
Archaeological Resources	Gulf of Mexico - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills. Alaska - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills.	Gulf of Mexico - **Minor** from routine activities, none in Eastern Gulf. - **Minor** to **moderate** from large oil spills. Alaska - **Minor** from routine activities regionally; none in Hope and Norton Basins. - **Minor** to **moderate** from large oil spills regionally; none in Hope and Norton Basins.

Note: Impact levels for oil spills are based on the assumption that one or more large oil spills occur and contact the resource.

2.4. Alternative 4—Accelerated Leasing

2.4.1. Description

Alternative 4 would hold 23 sales in eight planning areas (Table 4-4a):

- Central Gulf of Mexico—5 annual sales
- Eastern Gulf of Mexico—3 sale

- Western Gulf of Mexico—5 annual sales
- Beaufort Sea—5 sales
- Chukchi Sea—1 sale
- Hope Basin—1 sale
- Cook Inlet—2 sale
- Norton Basin—1 sale

Under alternative 2, the pace of leasing would be greater in the Eastern Gulf of Mexico and Beaufort Sea Planning Areas because more sales would be offered than for alternative 1. There would be three sales rather than two in the Eastern Gulf of Mexico and five sales rather than three in the Beaufort Sea. The same means of transporting hydrocarbons to shore from production facilities would be used for alternatives 1 and 4. It is assumed that oil spills would occur with uniform frequency over the life of the OCS activities resulting from this alternative. Also, it is assumed that the number of spills from import tankers could decrease slightly in the Gulf of Mexico and on the west coast because some of the imported oil would be replaced by the oil and gas produced as a result of the additional sale.

2.4.2. Comparison of Impacts

Under alternative 4, the amount of hydrocarbons anticipated to be produced would be greater than for alternative 1 in the Eastern Gulf of Mexico and the Beaufort Sea because there would be more sales in those planning areas. Relatedly, there will be a somewhat greater level activity in these two planning areas for this alternative than for alternative 1, the proposed action.

In the Gulf of Mexico, this alternative would add a third sale in the Eastern Gulf of Mexico Planning Area. The area considered for lease would be the same area as considered under alternative 1. This additional sale is expected to result in the production of additional oil and gas resources and would cause a corresponding increase in the level of exploration, development, and production activity in the Eastern Gulf and support facilities in the Central Gulf. There would be no change in the lease schedule in the Central and Western Gulf of Mexico Planning Areas where sales would be held annually. All oil produced in the Eastern Gulf program area is assumed to be transported via pipeline to existing or projected facilities in the Central Planning Area. If three sales were held in the Eastern Gulf of Mexico Planning Area, up to three new gas pipeline landfalls could result, and possibly one or two new pipeline shore facilities could be built in Louisiana or Alabama.

In the Alaska Region, alternative 4 would add two sales in the Beaufort Sea. The area considered for lease would be the same area considered under alternative 1. There would be no change in the number of sales or the configuration of the program areas for the other Alaska planning areas. The additional sales in the Beaufort Sea are expected to result in the production of additional oil and gas resources, and there would be a corresponding increase in the level of exploration, development, and production activity in the Beaufort Sea.

The activities potentially causing impacts are the same for both alternatives, and impact levels for many resources cannot be differentiated for the affected resources, either at the local or regional level, based on the slight differences in levels of activity in the Eastern Gulf estimated at this programmatic stage. However, impacts for two resources in Alaska are expected to increase. The increase in noise disturbance from routine activities could cause moderate impacts to the bowhead whale and additional sales in the Beaufort Sea are likely to have major effects on sociocultural systems on the North Slope.

In summary, impacts could be somewhat greater locally, but the impact levels will be the same as alternative 1 for the following resources if alternative 4 were adopted:

- water quality
- marine mammals
- terrestrial mammals (Alaska)
- marine and coastal birds (Alaska)
- fish resources and essential fish habitat
- sea turtles (Gulf of Mexico)
- commercial and recreational fisheries (Alaska)
- coastal habitats (Alaska)
- seafloor habitats (Alaska)
- parks, reserves, and refuges (Alaska)
- demography, employment, and regional income (Alaska)
- land use and existing infrastructure (Alaska)
- sociocultural systems and environmental justice (Alaska)

The only threat to resources along the Pacific coast from the proposed program would be from the transportation of OCS oil from the port of Valdez to west coast ports. If alternative 4 were adopted, the amount of OCS oil transported from Valdez is estimated to increase, and the number of spills that could occur from tankers carrying that oil to west coast ports could increase as well. Adopting this alternative could result in impacts to environmental resources in the Pacific Region similar to impacts from the proposal. The nature and severity of these impacts is predicted to be the same as those described for the proposed action.

A summary of the environmental impacts of alternatives 1 and 4 are presented below in comparative form.

RESOURCE	ALTERNATIVE 1	ALTERNATIVE 4
Water Quality	Gulf of Mexico - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills. Alaska - **Negligible** to **minor** from routine activities. - **Minor** to **moderate** from large oil spills.	Gulf of Mexico - **Minor** from routine activities regionally; somewhat greater locally. - **Minor** to **moderate** from large oil spills regionally; somewhat greater in locally. Alaska - **Negligible** to **minor** from routine activities. - **Minor** to **moderate** from large oil spills regionally; somewhat greater in the Beaufort Sea.
Air Quality	Gulf of Mexico - **Minor** from routine activities. - **Minor** from large oil spills. Alaska - **Minor** from routine activities. - **Minor** from large oil spills.	Gulf of Mexico - **Minor** from routine activities. - **Minor** from large oil spills. Alaska - **Minor** from routine activities. - **Minor** from large oil spills.

RESOURCE	ALTERNATIVE 1	ALTERNATIVE 4
Marine Mammals	Gulf of Mexico Manatee - **Negligible** from routine activities. All Others - **Minor** from routine activities. Manatee - **Minor** to **moderate** from large spills. Sperm Whale - **Minor** from large spills. All Others - **Minor** to **moderate** from large spills. Alaska Bowhead and Cook Inlet Beluga Whales - **Minor** to **moderate** from routine activities. Other Cetaceans - **Negligible** to **minor** from routine activities. Cook Inlet Beluga Whales - **Minor** to **major** from large oil spills. Other Cetaceans - **Negligible** to **moderate** from large oil spills. Pinnipeds - **Negligible** to **minor** from routine activities. - **Minor** to **major** from large oil spills. Polar Bears - **Minor** to **moderate** from routine activities. - **Minor** from large oil spills. Sea Otters - **Negligible** from routine activities. - **Moderate** from large oil spills.	Gulf of Mexico Manatee - **Negligible** from routine activities. All Others - **Minor** from routine activities; somewhat greater locally. Manatee - **Minor** to **moderate** from large spills. Sperm Whale - **Minor** from large spills regionally; somewhat greater locally. All Other - **Minor** to **moderate** from large spills regionally; somewhat greater locally. Alaska Bowhead Whales - **Moderate** from routine activities. Other Cetaceans - **Negligible** to **minor** from routine activities regionally; somewhat greater in the Beaufort Sea. Cook Inlet Beluga Whales - **Minor** to **moderate** from routine activities. - **Minor** to **major** from large oil spills. Other Cetaceans - **Negligible** to **moderate** from large oil spills. Pinnipeds - **Negligible** to **minor** from routine activities regionally; somewhat greater in the Beaufort Sea. - **Minor** to **major** from large oil spills. Polar Bears - **Minor** to **moderate** from routine activities; somewhat greater in the Beaufort Sea area. - **Minor** from large oil spills; somewhat greater in the Beaufort Sea area. Sea Otters - **Negligible** from routine activities. - **Moderate** from large oil spills.
Terrestrial Mammals	Gulf of Mexico - **Negligible** from routine activities and large spills. Alaska Grizzly Bear, Black Bear, River Otter, and Sitka Black-Tailed Deer - **Negligible** to **minor** from routine activities. - **Minor** to **moderate** from large oil spills. Caribou, Muskox, Arctic Fox, - **Minor** from routine activities and large spills.	Gulf of Mexico - **Negligible** from routine activities and large spills. Alaska Grizzly Bear, Black Bear, River Otter, and Sitka Black-Tailed deer - **Negligible** to **minor** from routing activities. - **Minor** to **moderate** from large spills. Caribou, Muskox, Arctic Fox, - **Minor** from routine activities and large spills regionally; somewhat greater in the Beaufort Sea area.

RESOURCE	ALTERNATIVE 1	ALTERNATIVE 4
Marine and Coastal Birds	Gulf of Mexico - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills. Alaska Listed and Nonlisted Birds (arctic) - **Negligible** to **minor** from routine activities Nonlisted Birds (subarctic) - **Negligible** to **moderate** from routine activities Listed and Nonlisted Birds (arctic and subarctic) - **Minor** to **major** from large oil spills	Gulf of Mexico - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills. Alaska Listed and Nonlisted Birds (arctic) - **Negligible** to **minor** from routine activities; somewhat greater on the North Slope. Nonlisted Birds (subarctic) - **Negligible** to **moderate** from routine activities Listed and Nonlisted Birds (arctic and subarctic) - **Minor** to **major** from large oil spills; somewhat greater on the North Slope.
Fish Resources	Gulf of Mexico - **Minor** from routine activities and oil spills. Alaska - **Negligible** to **moderate** from routine activities. - **Minor** to **moderate** from large oil spills.	Gulf of Mexico - **Minor** from routine activities and large spills regionally; somewhat greater locally. Alaska - **Negligible** to **moderate** from routine activities regionally; somewhat greater in the Beaufort Sea. - **Minor** to **moderate** from large spills regionally; somewhat greater in the Beaufort Sea.
Sea Turtles	Gulf of Mexico - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills.	Gulf of Mexico - **Minor** to **moderate** from routine activities and large oil spills regionally; somewhat greater locally.
Coastal Habitats	Gulf of Mexico Beaches and Dunes - **Minor** from routine activities and large spills. Wetlands - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills. Alaska - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills.	Gulf of Mexico Beaches and Dunes - **Minor** from routine activities and large spills. Wetlands - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills. Alaska - **Minor** to **moderate** from routine activities and oil spills regionally; somewhat greater on the North Slope.
Seafloor Habitats	Gulf of Mexico Topographic Features - **Negligible** from routine activities. - **Minor** from oil spills. Live Bottoms and Pinnacles - **Minor** from routine activities and large spills. Seagrass Beds - **Minor** from routine activities. - **Minor** to moderate from large oil spills. Chemosynthetic Communities - **Minor** from routine activities and large spills. Alaska Stefansson Sound Boulder Patch - **Negligible** to **moderate** from routine activities and large oil spills. Other Seafloor Habitats - **Minor** from routine activities and large spills.	Gulf of Mexico Topographic Features - **Negligible** from routine activities. - **Minor** from oil spills. Live Bottoms and Pinnacles - **Minor** from routine activities and oil spills. Seagrass Beds - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills. Chemosynthetic Communities - **Minor** from routine activities and large spills. Alaska Stefansson Sound Boulder Patch - **Minor** to **major** from routine activities. - **Negligible** to **moderate** from large oil spills. Other Seafloor Habitats - **Minor** from routine activities regionally, slightly greater in the Beaufort Sea. - **Minor** from large oil spills.

RESOURCE	ALTERNATIVE 1	ALTERNATIVE 4
Areas of Special Concern	<u>Gulf of Mexico</u> Parks, Refuges, and Reserves - **Negligible** to **minor** from routine activities. - **Minor** to **moderate** from large oil spills. Flower Garden Banks - **Negligible** from routine activities. - **Minor** from large oil spills. Florida Keys Marine Sanctuary - **Negligible** from routine activities and large spills. <u>Alaska</u> EFH - **Minor** from routine activities. - **Moderate** from large oil spills. Parks - **Negligible** from routine activities. - **Negligible** to **moderate** from large oil spills. Refuges and Forests - **Negligible** to **minor** from routine activities. - **Minor** to **moderate** from large oil spills.	<u>Gulf of Mexico</u> Parks, Refuges, and Reserves - **Negligible** to **minor** from routine activities. - **Minor** to **moderate** from large oil spills. Flower Garden Banks - **Negligible** from routine activities. - **Minor** from large oil spills. Florida Keys Marine Sanctuary - **Negligible** from routine activities and large spills. <u>Alaska</u> EFH - **Minor** from routine activities regionally; somewhat greater in the Beaufort Sea. - **Moderate** from large oil spills regionally; somewhat greater in the Beaufort Sea. Parks - **Negligible** from routine activities. - **Negligible** to **moderate** from large oil spills. Refuges and Forests - **Negligible** to **minor** from routine activities. - **Minor** to **moderate** from large oil spills except somewhat greater in ANWR.
Population, Employment, and Regional Income	<u>Gulf of Mexico</u> - **Negligible** to **minor** from routine activities. - **Negligible** from large oil spills. <u>Alaska</u> - **Minor** from routine activities and large oil spills; **moderate** locally from large oil spills.	<u>Gulf of Mexico</u> - **Negligible** to **minor** from routine activities. - **Negligible** from large oil spills. <u>Alaska</u> - **Minor** from routine activities and large oil spills; **moderate** locally from large oil spills.
Land Use and Infrastructure	<u>Gulf of Mexico</u> - **Negligible** to **moderate** from routine activities. - **Major** for Port Fourchon. - **Minor** from large oil spills. <u>Alaska</u> - **Moderate** from routine activities. - **Minor** to **moderate** from large oil spills.	<u>Gulf of Mexico</u> - **Negligible** to **moderate** from routine activities. - **Major** for Port Fourchon. - **Minor** from large oil spills. <u>Alaska</u> - **Moderate** from routine activities regionally; somewhat greater on the North Slope. - **Minor** to **moderate** from large oil spills regionally; somewhat greater on the North Slope.
Fisheries	<u>Gulf of Mexico</u> - **Minor** to **moderate** from routine activities. - **Minor** from large oil spills. <u>Alaska</u> Gulf of Alaska - **Negligible** to **minor** from routine activities. - **Minor** to **moderate** from large oil spills. Bering Sea - **Negligible** to **minor** from routine activities. - **Negligible** from large oil spills.	<u>Gulf of Mexico</u> - **Minor** to **moderate** from routine activities regionally; somewhat greater locally. - **Minor** from large oil spills regionally; somewhat greater locally. <u>Alaska</u> Gulf of Alaska - **Negligible** to **Minor** from routine activities. - **Minor** to **Moderate** from large oil spills Bering Sea - **Negligible** to **Minor** from routine activities. - **Negligible** from large oil spills.
Tourism and Recreation	<u>Gulf of Mexico</u> - **Negligible** from routine activities. - **Minor** to **moderate** from large oil spills. <u>Alaska</u> - **Minor** to **Moderate** from routine activities and large oil spills.	<u>Gulf of Mexico</u> - **Negligible** from routine activities. - **Minor** to **moderate** from large oil spills. <u>Alaska</u> - **Minor** to **moderate** from routine activities. - **Minor** to **moderate** from large oil spills.

RESOURCE	ALTERNATIVE 1	ALTERNATIVE 4
Sociocultural Systems and Environmental Justice	Gulf of Mexico Sociocultural Systems - **Negligible** to **moderate** from routine activities. - **Negligible** from large oil spills. Alaska Sociocultural Systems - **Minor** to **moderate** from routine activities. - **Minor** to **major** from large oil spills. Environmental Justice - **Disproportionately high** impacts from large oil spills.	Gulf of Mexico Sociocultural Systems - **Negligible** to **moderate** from routine activities. - **Negligible** from large oil spills. Alaska Sociocultural Systems - **Minor** to **moderate** from routine activities regionally; **major** on the North Slope. - **Minor** to **major** from large oil spills. Environmental Justice - **Disproportionately high** impacts from large oil spills.
Archaeological Resources	Gulf of Mexico - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills. Alaska - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills.	Gulf of Mexico - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills. Alaska - **Minor** from routine activities. - **Minor** to **moderate** from large oil spills.

Note: Impact levels for oil spills are based on the assumption that one or more large oil spills occur and contact the resource.

2.5. Alternative 5—No Action

The evaluation of a "no-action" alternative is required by the regulations implementing the National Environmental Policy Act (40 CFR 1502.14(d)). If the Secretary were to adopt this alternative, it would halt OCS presale planning, sales, and new leasing from mid-2002 to mid-2007 even in the Central and Western Gulf of Mexico Planning Areas. However, exploration, development, and production stemming from past sales would continue.

2.5.1. Description

This alternative would shut down the OCS leasing program from mid-2002 through mid-2007. The amounts of OCS natural gas (between 13 and 26 thousand cubic feet) and oil (between 5.4 and 14.7 billion barrels of oil) required to meet national energy needs would be forgone. That amount of energy would have to be replaced by a combination of imports, alternative energy sources, and conservation.

Market forces are expected to be the most important determinant of the substitute mix for OCS oil and gas (Table 4-5c). Key market substitutes for forgone OCS oil production would be imported oil (88%, conservation (6%), switching to gas (4%), and onshore production (3%). For OCS natural gas the principal substitutes would be switching to oil (40%), onshore production (28%), imports (16%), and conservation (16%).

In addition to market-based substitutes, the Nation or individual States might choose to encourage or even impose programs designed to deal with the energy shortfall. To replace oil, these programs might favor alternative vehicle fuels such as ethanol or methanol, vehicles with greater fuel efficiency, or alternate transportation methods such as mass transit.

As a partial replacement for the forgone natural gas, governments might mandate increased reliance on coal, nuclear, hydroelectric, or wind-generated electric power. In addition, governments might give more emphasis to programs encouraging more efficient electricity transmission and more efficient use of gas and electricity in factories, offices, and homes.

3. AFFECTED ENVIRONMENT

3. AFFECTED ENVIRONMENT

3.1. Gulf of Mexico Region

3.1.1. Physical Environment

3.1.1.1. Geology

The Gulf of Mexico is a passive continental margin, that is, one where crustal plates are moving away from one another rather than converging. Passive continental margins are geologically stable, with few earthquakes and little volcanism. Because of this relative stability, large quantities of sediments washed into the sea from upland sources accumulate adjacent to the continents and form wide, shallow continental shelves (Martin, 1978; Gross, 1993). The most important factor affecting the potential for oil and gas in the northern Gulf is the environment of deposition (U.S. Department of the Interior [USDOI], Minerals Management Service [MMS], 1997a). Sediments deposited on the outer shelf and upper slope have the greatest potential for hydrocarbon accumulation because these are the optimum zones for the availability of source material, reservoir space, and geologic traps.

The regional basinward dip of Gulf of Mexico sediments is interrupted by salt diapirs, growth faults, and shale diapirs. Regional systems of growth faults parallel to the coastline penetrate into the Cenozoic units beneath coastal Texas and Louisiana and the adjacent shelf. Growth faults, forming contemporaneously with sedimentation, resulted in throws of thousands of feet increasing with depth and strata on the downthrown side, thicker than on the upthrown side (Martin et al., 1984).

The natural gas and oil prospective horizons of the northwestern continental shelf are of Miocene, Pliocene, or Pleistocene age. Sediments deposited on the outer shelf and upper slope have the greatest potential for bearing hydrocarbons. These environments are the optimum zones for encountering the three conditions necessary for the successful formation and accumulation of oil and gas: reservoir rocks, source beds, and traps. Sediments deposited on the outer shelf and upper slope have the greatest potential for bearing hydrocarbons due to the following reasons:

- Nearshore sands interfinger with the deeper-water marine shales, providing an optimum ratio of sandstone to shale (25-35% sand). The shale may be the source rock that provides the oil and gas while the sandstone provides the reservoir into which the hydrocarbons migrate and are trapped.
- In this environment, the organic material deposited with the fine-grained clays and muds is preserved and not oxidized as it might be in more shallow, more turbulent water.
- The increased overburden of the prograding shallow marine deposits over the plastic Luann salt and marine shales initiates the salt flow that triggers the growth of salt domes and regional expansion faults which provide traps for hydrocarbons.

The most prolific offshore production to date in the Gulf has come from the Miocene age strata of the eastern Louisiana Outer Continental Shelf (OCS). This area has more oil than the remainder of the Texas-Louisiana area. The next most productive trend is the Pliocene trend of the central Louisiana OCS, which produces oil and gas in similar quantities. Further to the west, this producing trend dies out. The Miocene of western Louisiana is the third most productive trend, producing mostly gas, and the Pleistocene of offshore western Louisiana ranks fourth.

Within the Gulf of Mexico, major geologic hazards to oil and gas development are associated with seafloor geologic features that could result in seafloor instability. Seafloor instability is considered the principle engineering constraint to the emplacement of bottom-founded structures, including pipelines, drilling rigs, and production platforms. Primarily, the hazards are produced by:

- increased gradient at the edge of the continental shelf where it merges with the continental slope;
- regional high rates of deposition on the continental shelf that cause isostatic adjustments and deep-seated gravity faulting;
- local high rates of deposition of unconsolidated sediments on the increased gradient of the continental shelf edge that has led to intensive slumping and mudslides;
- diapiric movement of low-density material through overlying sediment that has caused extensive deformation, the damming of sediments, gravity faulting, and slumping;
- high, biogenic gas content in rapidly deposited sediments; and
- karst features on the West Florida Carbonate Platform (Figure 3-1).

Many of the exploration, development, and pipeline plans associated with oil and gas development in the Gulf of Mexico identify geologic hazards. The primary geologic hazard factor to Gulf of Mexico OCS operations is the rapid deposition of fine-grained, underconsolidated sediments. These sediments restrict the extrusion of pore fluids to create a condition called "overpressuring." Under normal circumstances, sediments compact by allowing pore fluids to escape. Overpressuring may lead to slumping and mudslides that can disrupt the drilling of wells or the laying of pipelines. Special drilling procedures are used in zones of abnormally high pore pressure.

Shallow gas in near-surface sediments is another geologic hazard that can cause concern for oil and gas operators. Decomposition of trapped organic matter is the primary source of biogenic gas. Thermogenic gas, originating in deeply buried source rocks, can migrate upward and also become trapped in shallow sediments. Drilling into gas can pose problems since a large amount of gas can lower the density of the mud and can contribute to seafloor instability and slope failure.

Studies developed under the MMS Environmental Studies Program have been directed toward areas where more detailed geologic information was needed for management of the OCS mineral leasing program. These studies have provided assessments of operational constraints to oil and gas exploration and production. The data and mapped information are being used on a daily basis for tract evaluation, stipulation development and application, pipeline permit processing, protection of sensitive areas such as the Flower Garden Banks, preliminary platform emplacement, and pipeline routing.

There has been considerable debate regarding the influence of bottom currents on the distribution of sediments in the deepwater environment. Roberts et al. (1982) suggested that certain bedform erosions in the Gulf were the result of oceanic currents, while Martin and Bouma (1982) suggested that slumping was the cause of bed truncations. Recent surveys conducted by Texas A&M University on the lower continental slope of the Gulf of Mexico have confirmed that deepwater processes have produced megafurrows (i.e., spaced at 20-meter [m] intervals, measuring 5 m wide) parallel to the bathymetric contour lines southward of the Sigsbee Escarpment. These megafurrows suggest swift bottom currents in water depths of over 3,000 m (Bryant and Liu, 2000). Today, terrestrial sands and silts cover more than 35 percent of the Gulf of Mexico (Davies, 1972).

3.1.1.2. Meteorology and Air Quality

Climate

The Gulf of Mexico is influenced by a maritime subtropical climate controlled mainly by the clockwise wind circulation around a semipermanent area of high barometric pressure alternating between the Azores and Bermuda Islands. This circulation, around the western edge of the high pressure cell, results in the predominance of moist southeasterly wind flow in the region. During the winter months, December through March, cold fronts associated with outbreaks of cold, dry continental air masses influence mainly the northern coastal areas of the Gulf of Mexico. Tropical cyclones may develop or migrate into the Gulf of Mexico during the warmer season, especially in the months of August through October. In coastal areas, the land-sea breeze is frequently the primary circulation feature in the months of May through October.

In the warmest month in the summer, average temperatures in the Gulf coastal areas range from about 26 to 28 degrees Celsius (°C) (79 to 82 degrees Fahrenheit [°F]). During the warm months, there is little diurnal, daily or spatial variation in temperature. Average temperatures for the coldest month in winter range from about 10 °C (50 °F) in the northern coastal areas to about 21 °C (70 °F) in the southernmost locations in Texas and Florida. In the colder months, there is more variability in temperature, mainly in the more northern areas. Air temperatures over the open Gulf exhibit smaller daily and seasonal variations due to the moderating effects of large bodies of water. The average temperature over the center of the Gulf is about 29 °C (84 °F) in the summer and between 17 and 23 °C (63° and 73 °F) in the winter.

The relative humidity over the Gulf and the coastal areas is high, especially during the warmer months. Lower humidities in the winter season are associated with outbreaks of cool, dry, continental air from the interior. Winds are generally southeasterly to southerly in the summer season, but are more variable in the coastal regions because of effects of the land-sea breeze circulation systems. Winds are more changeable in the winter season because of changing atmospheric pressure patterns and frontal passages.

Precipitation is frequent and abundant throughout the year, but tends to peak in the summer months. Mean annual rainfall ranges from about 77 centimeters (cm) (30 inches) along parts of the Texas Gulf Coast to 155 cm (60 inches) in the Florida Panhandle. Rainfall in the warmer months is usually associated with convective cloud systems that produce showers and thunderstorms. Winter rains are associated with the passage of frontal systems through the area. Fog occurs occasionally in the cooler season as a result of warm, moist Gulf air blowing over cool land or water surfaces. The poorest visibility conditions occur from November through April. During air stagnation, industrial pollution and agricultural burning also can impact visibility.

Atmospheric stability and mixing height provide a measure of the amount of vertical mixing of pollutants. Over water, the atmosphere tends to be neutral to slightly unstable since there is usually a positive heat and moisture flux. Over land, the atmospheric stability is more variable, being unstable during the daytime, especially in the summer months due to rapid surface heating, and stable at night, especially under clear conditions in the cooler season. The mixing height over water typically ranges between 500 m to 1,000 m with a slight diurnal variation. Mixing height over land can be 1,500 m or greater during the afternoon in the summertime and near zero during clear, calm conditions at night in the wintertime.

Tropical cyclones affecting the Gulf originate over the tropical portions of the Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico, and occur most frequently between June and September. On average, about 10 tropical cyclones occur in the Atlantic Basin, 5 of which become major hurricanes. About 3.7 tropical cyclones per year will affect the Gulf of Mexico (USDOI, MMS, 1988). Tropical storms cause damage to physical, economic, biological, and social systems in the Gulf, but the severest effects tend to be highly localized. The Gulf of Mexico is also periodically affected by wintertime, extratropical cyclones generated when continental, cold air outbreaks interact with the warm Gulf waters. These storms can produce gale force winds and high seas and are hazardous to shipping due to their sudden and rapid formation. For effects of hurricanes and severe storms on OCS oil operations in the Gulf see Section 4.3.2.2.

Air Quality

Air quality of the coastal areas bordering the Gulf of Mexico can be described by comparing measured ambient concentrations of pollutants against the national ambient air quality standards (NAAQS) established by the U.S. Environmental Protection Agency (USEPA) under the Clean Air Act. The NAAQS have been established for the so-called criteria pollutants, which are nitrogen dioxide (NO_2), sulfur dioxide (SO_2), fine particulate matter (PM_{10}), carbon monoxide (CO), and ozone (O_3). Any individual State may adopt a more stringent set of standards. The State of Florida has ambient standards for SO_2 that are somewhat more stringent than the NAAQS.

All of the Gulf coastal counties meet the NAAQS for NO_2, SO_2, CO, and PM_{10}. However, the ozone standard is exceeded in a number of counties in Texas and Louisiana. Figure 3-2 shows the areas that are classified nonattainment for ozone. There are ten counties in southeastern Texas that do not meet the Federal standards for ozone, all of them centered around the Houston, Galveston, Beaumont, and Port Arthur urban areas. The USEPA has established four categories of ozone nonattainment areas depending on the severity of the problem. These are marginal, moderate, serious, and severe. The seven counties around Houston and Galveston are classified as severe. The three counties in the Beaumont and Port Arthur areas are classified as serious. During the monitoring period of 1998 through 2000, the highest 1-hour average ozone concentration in Houston was 0.25 parts per million (ppm). Values greater than 0.20 ppm have been measured at many of the monitoring stations within the Houston metropolitan area. There was an average of about 9 days per year when the ozone standard was exceeded. The highest 1-hour average ozone concentration in Galveston was 0.21 ppm. In the Beaumont and Port Arthur area, elevated ozone levels occur less frequently than in Houston. There was an average of about one to two days per year when the ozone standard was exceeded. The highest 1-hour average ozone concentration in Beaumont and Port Arthur was 0.15 and 0.16 ppm, respectively.

In Louisiana, six parishes are classified nonattainment for ozone, five of which are located around Baton Rouge (Figure 3-2). The five Baton Rouge parishes are classified in the serious category. In the 1998 through 2000 monitoring period, the highest 1-hour average ozone concentration was 0.16 ppm. There is an average of about 1-2 days per year when the Federal ozone standard is exceeded. In Lafourche Parish, there were four exceedances of the ozone standard in 1995, which resulted in it being classified nonattainment. There were no exceedances in the years 1996 through 1999, but there was one in 2000. Coastal areas of Mississippi and Alabama are classified attainment for ozone.

In Escambia County in the Florida Panhandle, there have been exceedances of the ozone standard. There were four exceedances at one monitoring station in Pensacola in the years 1998 through 2000. This number of exceedances within a 3-year period would make it nonattainment for ozone.

The USEPA has promulgated revised ambient standards for ozone and particulate matter (Federal Register, July 18, 1997). The revised ozone standard is based on an 8-hour average ozone concentration of 0.08 ppm. The former ozone standard was a 1-hour average concentration of 0.12 ppm, which cannot be exceeded more than once a year. A new standard was set for fine particulate matter ($PM_{2.5}$). The USEPA implemented a monitoring program to determine the classification of the various air quality planning areas with respect to compliance with the new standards. However, the revised air quality standards are currently under litigation, and no compliance designations have been made to date. If the 8-hour ozone standard is implemented, it is likely that there would be a number of coastal counties in Louisiana, Mississippi, Alabama, and Florida that would not meet that new standard. This is because the 8-hour standard is more stringent than the one based on a 1-hour average. Areas that presently meet the 1-hour standard may not be able to meet the new 8-hour ozone standard.

The largest sources of nitrogen oxide (NO_x) emissions are vehicles and electric utilities. Other important sources are nonroad engines and vehicles and industrial plants. In southeastern Texas and southern Louisiana, petroleum refining and chemical plants provide a substantial contribution to volatile organic compound (VOC) emissions. Other important sources are solvents (industrial solvents, paints, consumer solvents, dry cleaning), vehicles, nonroad engines and vehicles, and petroleum storage and transport.

Class I Federal areas have been designated for mandatory Prevention of Significant Deterioration (PSD) of air quality, including such air quality related values as visibility. Class I areas are located in two of the five Gulf Coast States: Louisiana and Florida. In Louisiana there is one Class I area, and Florida has three. The Class I area offshore Louisiana is comprised of the Breton Wildlife Refuges, located on Breton Island and on many of the Chandeleur Islands. Figure 3-3 shows the locations of the Class I areas in the Gulf coastal zones.

3.1.1.3. Physical Oceanography

The Gulf of Mexico is connected to the Caribbean Sea and the Atlantic Ocean via the Yucatan Channel and the Florida Straits, respectively. The Loop Current, the dominant circulation feature in the Gulf, enters through the Yucatan Channel and exits through the Florida Straits (Figure 3-4). The sill depth at the Florida Straits is about 800 m. Because the sill depth at the Yucatan Channel is less than 1,800 m, water masses in the Atlantic Ocean and Caribbean Sea that occur at depths exceeding this cannot enter the Gulf of Mexico.

The Loop Current dominates circulation in the Gulf of Mexico. A typical location is presented in Figure 3-4. The extent of intrusions of the Loop Current into the Gulf of Mexico varies and may be related to the location of the current on Campeche Bank at the time it separates from the Bank. Filaments of the Loop Current have been observed to intrude onto the continental slope east of the Mississippi River Delta. Another Loop Current associated circulation feature is anticyclonic Loop Current eddies, which are closed, clockwise rotating rings of water that separate from the Loop Current. Major Loop Current eddies have diameters on the order of 300-400 kilometers (km) and may extend vertically to a depth of about 1,000 m. Once these eddies are free from the Loop, they travel into the western Gulf along various paths to a region between 25^{o} N. to 28^{o} N. latitude and 93^{o} to 96^{o} W. longitude. It is thought that separation of these eddies from the Loop Current occurs aperiodically. Eddies can have lifetimes exceeding 1 year (Elliott, 1982). Currents associated with the Loop Current and its eddies can have surface speeds of 150 to 200 centimeters per second (cm/s) or more; speeds of 300 cm/s have been observed. At depth of 500 m, speeds of 10 cm/s can occur (Cooper et al., 1990).

In addition to currents associated with the Loop Current and associated mesoscale eddies, there are two significant circulation features in the Gulf of Mexico (Figure 3-4). One is a permanent anticyclonic (clockwise rotating) feature oriented about ENE-WSW with its western extent near

24° N. latitude off Mexico. The causal mechanism for this anticyclonic circulation and the associated western boundary current along the coast of Mexico is debatable (Sturges and Blaha, 1975; Elliott, 1979, 1982; Blaha and Sturges, 1981; Sturges, 1993) but is suspected to be wind-driven (Oey, 1995). The second feature is a cyclonic gyre centered in the Bay of Campeche near 20.8° N. latitude, 94.5° W. longitude (Vazquez de la Cerda, 1993). This circulation feature is also thought to be wind-driven (Nowlin et al., 2000).

Shelf circulation is complicated because of the large number of forces and seasonality of driving forces. Cochrane and Kelly (1986) examined the prevailing circulation on the Texas-Louisiana continental shelf. With the exception of July-August, there appears to be a cyclonic (rotating counter-clockwise) gyre present over this part of the northern Gulf of Mexico continental shelf in response to prevailing wind stress (Figure 3-4). On the inner shelf, currents flow downcoast (west-southwestward). A corresponding countercurrent, which completes the gyre system, occurs along the shelf break. At the southwestern end of the gyre, the convergence migrates seasonally with the direction of the prevailing wind, ranging from a point south of the Rio Grande in the fall to the Cameron area by July. In July, the cyclonic system is replaced by an anticyclone (rotating clockwise) offshore Louisiana, which has formed in response to the upcoast component of the wind. In August and September, the direction of the prevailing winds change to downcoast, and the cyclonic gyre is reestablished.

Circulation on the Mississippi-Alabama shelf is dynamic because a number of factors are involved, including the Loop Current and associated intrusions, tides, winds, and freshwater inflow. Kelly (1991) reported results from current meter moorings that agreed with a mean cyclonic circulation cell as suggested by Dinnel (1988), and stating that the wind-driven flow on the inner shelf was westward and that the return eastward flow occurred over the mid- and outer shelf (Figure 3-4). Three types of intrusions have been identified: (1) Loop Currents push up the axis or east side of De Soto Canyon; (2) frictional entrainment of outer shelf water into the outer periphery of the Loop Current or an eddy filament derived from the Loop Current; and (3) direct intrusion of diluted Loop Current water onto the shelf. These phenomena can markedly alter the general wind-driven circulation of the continental shelf. Because the intrusions are random, frequent, strong, and have variable areal coverage, they are an important influence on the circulation in this region.

The flow structure on the west Florida continental shelf consists of three regimes: the outer shelf, the mid-shelf, and the coastal boundary layer. The Loop Current and eddy-like perturbations more strongly affect the circulation on the outer shelf. During Loop intrusion events, upwelling of colder, nutrient-rich waters has been observed. In water depth less than 30 m the wind-driven flow is mostly alongshore and parallel to the isobaths. A weak mean flow is directed southward in the surface layer. In the coastal boundary layer, longshore currents driven by winds, tides, and density gradients predominate over the cross-shelf component (Science Applications International Corporation (SAIC), 1986).

In deep water, there are several additional types of currents in addition to the Loop Current, eddies, and permanent gyres. There are deep barotropic currents; subsurface-intensified, high-speed jets; and a class of deep currents that was detected by documenting their effects in producing long, deep, linear furrows in the bottom sediments near the Sigsbee Escarpment. In deep water, barotropic (depth independent) currents have been observed to extend from depths near 1,000 m to the bottom. Barotropic currents have been observed with maximum speeds near 70 cm/s and lasting periods of weeks. Very high-speed, subsurface-intensified currents lasting of the order of a day have been observed at locations over the upper continental slopes. These currents may have vertical extents of less than 100 m, with maxima observed generally within the depth range of 100-300 m, and maximum speeds exceeding 150 cm/s. In early 1999, previously unexplored bedforms were discovered just offshore of the Sigsbee Escarpment in the northwestern Gulf of Mexico by Dr. William Bryant of Texas A&M University. These consisted of large, megafurrows eroded into the seafloor, oriented nearly along depth contours, and having depths of 5-10 m and widths of several tens of meters. They are spaced on the order of 100 m apart, and extend unbroken for distances of tens of kilometers or more. The presence of these megafurrows suggests the presence of bottom currents that have along-isobath components and increase in strength toward the escarpment. These currents might be sporadic or quasi-permanent, and near-bottom speeds might be 50 cm/s or even in excess of 100 cm/s.

3.1.1.4. Water Quality

Marine Waters

Two aspects of the Gulf of Mexico are the primary influences on the composition of its marine waters. These are the configuration of the basin, which controls the oceanic waters that enter and leave the Gulf, and runoff from the land masses, which controls the quantity of freshwater input into the Gulf. The Gulf of Mexico receives oceanic water from the Caribbean Sea through the Yucatan Channel, and freshwater from major continental drainage systems such as the Mississippi River system. The large amount of freshwater runoff mixes into the Gulf surface water, producing a composition on the continental shelf that is different from the open ocean.

During the summer of 1993, unusually high freshwater outflows from the Mississippi and Atchafalaya Rivers occurred as a result of extreme flooding. These elevated outflows resulted in increased loadings of agricultural chemicals and sediments, as well as lower salinities and increased nutrient loadings (Dowgiallo, 1994). The effects of freshwater inflow into the Gulf of Mexico were detected in the Florida Keys and along the U.S. east coast, as well as in the northern Gulf of Mexico. Murray and Donley (1996) reported that the temperature and salinity characteristics of the Mississippi River plume were measurable over a broad area reaching just east of Galveston Bay in 1993 and 1994.

Hypoxic waters (oxygen concentration < 2 milligrams per liter [mg/L]) have been identified in a large area of the northern Gulf of Mexico near the mouth of the Mississippi River, at times reaching up to 16,500 square kilometers (km^2) of bottom waters on the inner continental shelf from the Mississippi River Delta to as far south as Freeport, Texas (Murray and Donley, 1996). An example of the extent of hypoxia in bottom waters of the northwestern Gulf of Mexico is presented in Figure 3-5. Hypoxic conditions can be responsible for massive die-off of benthic biota that are unable to move from areas where oxygen is depleted. Hypoxic conditions in the Gulf of Mexico vary spatially and seasonally. Conditions depend on the flow of the Mississippi River discharge and are affected by water circulation patterns, saltwater and freshwater stratification, wind mixing, tropical storms, and thermal fronts (Meier, 1996). Hypoxic conditions have been identified off the Mississippi River as early as February and as late as October. The causes of the hypoxic zone are not definitively known, but high summer temperatures combined with freshwater runoff carrying large amounts of excess nutrients from the Mississippi River are thought to be involved. The Mississippi-Alabama inner shelf has the potential for bottom-water hypoxia, and low oxygen concentrations have been documented. However, such events are not considered frequent or widespread (Rabalais, 1992).

The depth distributions of nutrients and dissolved oxygen in the deep Gulf of Mexico are similar to those of the Atlantic deep ocean. The dissolved oxygen has a surface maximum due to exchange with the atmosphere and production from photosynthesis, and the concentration decreases with depth as decomposition of organic matter depletes the oxygen. Nutrient profiles are the opposite of the dissolved oxygen profile. Their concentration in surface water is very low because they are depleted with the photosynthesis in the surface waters. In deeper waters, nutrient concentrations increase as organic matter decomposes, and nutrient concentrations are highest in deeper water.

The presence of a nepheloid layer is a common phenomenon in the Gulf, particularly on the shelf. This phenomenon is a near-bottom layer of turbid water that has greatly elevated levels of suspended material (> 1 ppm). This layer is separated from the overlying water by a sharp discontinuity in suspended particulate matter. Nepheloid layers appear to occur naturally at nearly all locations on the shelf and upper slope environments, except within the upper portions of significant topographic highs (Brooks et al., 1981). They may be associated with resuspension of sediments by bottom currents, internal waves, intense at-depth biological activity, or a complex combination of these factors. Nepheloid layers may contribute to the transport of materials, including contaminants, from nearshore to offshore areas.

Red tides, which are blooms of single-cell algae that produce potent toxins harmful to marine organisms and humans and are a natural phenomenon in the Gulf of Mexico, occur primarily off southwestern Florida and Mexico. These algal blooms can result in severe economic and public health problems, and are responsible for fish kills and invertebrate mortalities. There are ongoing studies to determine whether human activity that increases nutrient loadings to Gulf of Mexico waters contributes to the frequency and intensity of red tides.

Kennicutt et al. (1988c) summarized the information on elevated levels of organic compounds of environmental concern that have been measured in northern Gulf of Mexico offshore waters. Volatile organic compounds are generally more abundant in coastal and nearshore waters, and generally decrease with distance from shore. Chlorinated VOC's were generally restricted to nearshore waters; petroleum-related VOC's occur offshore. High-molecular-weight hydrocarbons are associated with biological production, natural seepage, offshore petroleum production, shipping activities, coastal and riverine runoff, and atmospheric exchange and fallout. The highest levels of high-molecular-weight-hydrocarbons occur near point sources in coastal environments and near natural seeps. Large areas off Florida and southern Texas are relatively pristine, but areas off northern Texas, Louisiana, and Alabama show detectable levels of petroleum hydrocarbons, likely from natural seepage. Organochlorine residues occur in many marine species, and higher concentrations of pollutants were generally found in organisms from the Mississippi Delta than in offshore biota (Kennicutt et al., 1988c).

There has been relatively little evaluation of anthropogenic inputs to the Gulf of Mexico slope area (depths > 200 m). This is due in part to the distance of the slope area from potential input sources and to the fact that processes that would transport contaminants over that distance would likely spread and consequently dilute the contamination over a large area. Exceptions are atmospheric transport and deposition of contaminants (such as nitrate and acid rain), oil production operations, and shipping operations. Oil production and shipping activities normally would affect a relatively small proportion of the slope area, with the exception of catastrophic accidents such as platform "blowouts" or shipping spills of hazardous materials such as oil.

There are limited data available regarding trace element concentrations in the deepwater Gulf of Mexico. While limited, the deepwater Gulf of Mexico trace element data suggest minimal anthropogenic inputs when compared to nearshore waters (Boyle et al., 1984). Metal concentrations are observed to increase with depth in deep water, most likely as a result of organic matter degradation similar to nutrient release (Boyle et al., 1984).

Coastal Waters

The USEPA (1999) has compiled an assessment of water quality within Gulf of Mexico estuaries and coastal waters. This assessment was based on data that were collected in 1996 by individual Gulf Coast States. About 78 percent of the Gulf's estuaries had been surveyed (39,666 km^2), and 65 percent of those surveyed had good water quality. The remainder was considered "impaired" due to nutrient enrichment, the influx of pathogens, increases in oil and grease concentrations, alteration of habitat, salinity and/or chloride intrusion, siltation, or organic enrichment. It was estimated that 5-20 percent of the estuaries in Louisiana were adversely affected. Organic enrichment and nutrient enrichment were documented in several estuaries in Mississippi and Texas. A limited number of estuaries in Alabama, Mississippi, and Texas had indications of the presence of pathogens.

Primary activities that have contributed or are still contributing to the degradation of coastal water conditions along the Gulf Coast include the petrochemical industry, agricultural, power plants, pulp and paper mills, fish processing, municipal wastewater treatment, maritime shipping, and dredging. The petrochemical industry along the Gulf Coast is the largest in the United States. This industry includes extensive onshore and offshore oil and gas development operations, tanker and barge transport of both imported and domestic petroleum into the Gulf region, and petrochemical refining and manufacturing operations.

There are more than 3,700 point sources of contamination flowing into the Gulf of Mexico (Weber et al., 1992). These point sources contribute contaminants through discharges and accidental releases, and about 460 of these point source inputs discharge directly into Gulf waters or estuaries. These include 113 municipalities that discharge more than a billion gallons (> 3.8 billion liters) per day of sewage effluent into Gulf coastal waters (Weber et al., 1992). Industrial sources number 192 in Texas, 79 in Louisiana, 30 in Mississippi, 29 in Alabama, and 17 in Florida. Most of these industry point sources are petroleum refineries and petrochemical plants.

Because 4 of the 10 busiest ports in the United States are located on the Gulf Coast, vessel traffic is another major point source of contamination to Gulf waters. Vessel-associated contamination includes bilge and waste discharges, spills, and leaching of tributyltin from ship hulls.

The quality of coastal waters is also altered by activities such as channelization, wetland dredge and fill modifications, and natural subsidence, which can result in sediment deficit and saltwater intrusion, particularly in the Louisiana coastal areas. Oil and gas projects in Louisiana generate about 9-10 million cubic meters (MMm^3) of dredged material every year, and most of the material dredged from the extensive navigation channel network is dumped at the 27 dredged-material disposal sites located along the Gulf coastline. An average of 25 MMm^3 of sediments is disposed at these sites annually. Disposal of dredged material results in temporarily increased turbidity and resuspension and may release sediment contaminants into coastal waters.

Nonpoint sources are difficult to regulate and currently have the greatest impact on the Gulf of Mexico coastal water quality. Nonpoint pollutant sources include agriculture, forestry, urban runoff, marinas, recreational boating, and atmospheric deposition. Waterways draining into the Gulf of Mexico transport wastes from 75 percent of U.S. farms and ranches, 80 percent of U.S. cropland, hundreds of cities, and thousands of industries located upstream of the Gulf of Mexico coastal zone. Urban and agricultural runoff contributes large quantities of pesticides, nutrients, and fecal coliform bacteria.

More pesticides are used in the Gulf coastal area than elsewhere in the country; more than 10 million pounds (about 4,500 metric tons) of pesticides were applied in 1987 (U.S. Department of Commerce

[USDOC], National Oceanic and Atmospheric Administration [NOAA], 1992a). In addition, the Gulf of Mexico ranked highest in the use of herbicides (6.6. million pounds [3,000 metric tons]) and fungicides. Large quantities of insecticides are also used in the Gulf coastal areas. Because of the high usage in the Gulf coastal areas, the Atchafalaya/Vermilion Bays, the Lower Laguna Madre, and Matagorda Bay are highly ranked estuarine drainage areas for carrying pesticides to coastal waters; however, only Tampa Bay and the Lower Laguna Madre drainage basins are highly ranked for estimated pesticide risk to estuarine organisms (USDOC, NOAA, 1992a).

One of the greatest concerns for Gulf of Mexico coastal water quality is an excess of nutrients, primarily from river runoff. Nutrient enrichment can lead to noxious algal blooms, decreased seagrasses, fish kills, and oxygen-depletion events. Over the last three decades, nitrogen and phosphorus loadings in the Mississippi River and Gulf of Mexico coastal waters have risen dramatically (Rabalais, 1992). Based on estimates of the Nutrient Enrichment Subcommittee of the Gulf of Mexico Program, about 172 metric tons of phosphorus and about 848 metric tons of nutrient nitrogen are discharged daily into the Gulf of Mexico, with 90 percent of these discharges originating from the Mississippi River system (Lovejoy, 1992). Excessive nutrient enrichment also has been a problem for the Lower and Upper Laguna Madre in Texas; Lake Pontchartrain, the Mississippi River mouth, and Barataria Bay in Louisiana; Mississippi Sound, Pascagoula Bay, and Biloxi Bay in Mississippi; and Perdido, Pensacola, Choctawhatchee, and St. Andrews Bays in Florida (Rabalais, 1992).

The frequency of fish kill events and closures of commercial oyster harvesting are good indicators of coastal and estuarine water quality. Between 1980 and 1989, 5 of the 10 most extensive fish kills reported in the United States occurred in Texas (USDOC, NOAA, 1992b). Because oysters are bottom-dwelling filter feeders, they concentrate pollutants and pathogens. Coliform bacteria contamination, primarily from septic tank runoff pollution, is responsible for the annual closure of about one-half of the harvestable shellfish beds in Louisiana.

The NOAA National Status and Trends (NS&T) Program has monitored the concentrations of synthetic chlorinated compounds such as dichlorodiphenyltrichloroethane (DDT), chlordane, polychlorinated biphenyls, tributyltin, polynuclear aromatic hydrocarbons, and trace metals in bottom-feeding fishes, shellfish, and sediments at coastal and estuarine sites along the Gulf of Mexico since 1984 (USDOC, NOAA, 1992c; O'Connor and Beliaeff, 1995). Based on the results of NOAA's NS&T Mussel Watch Program from 1986 to 1999, fewer contaminated sites were found along the Gulf Coast compared to other U.S. coastal areas, probably because urban centers along the Gulf Coast are farther inland than urban centers along other coasts. The highest concentrations of chlorinated hydrocarbons in Gulf of Mexico oysters were observed along the Mississippi to northern Florida coasts and at stations in Galveston Bay and Tampa Bay, and mercury was observed to be very high in Matagorda Bay, Texas (USDOC, NOAA, 1992c). Sediment data indicated that sites in the Gulf of Mexico had lower concentrations of toxic contaminants than the rest of the country, most likely because sampling sites in the Gulf coastal area were further removed from urban areas, which typically have large numbers of point-source discharges (O'Connor, 1990).

3.1.1.5. Acoustic Environment

The basic components of a sound wave are amplitude, wavelength, and frequency. Amplitude is proportional to the maximum distance a vibrating particle is displaced from the rest. Small variations in amplitude produce weak or quiet sounds, while large variations produce strong or loud sounds. Sound levels are measured in decibels (dB), a logarithmic dimensionless unit that is a ratio of the measured level to a reference level. Wavelength is the distance between two successive compressions or the distance the wave travels in one cycle of vibration. Frequency is the rate of oscillation or vibration of the wave particles (i.e., the rate amplitude cycles from high to low to high, etc.). Frequency is measured in cycles/sec or hertz (Hz). In humans, an increase in frequency is perceived as a higher pitched sound, while an increase in amplitude is perceived as a louder sound.

The underwater acoustic environment consists mainly of ambient noise, defined as environmental background noise lacking a single source or point. Sources of ambient noise in the ocean include the wind, waves, and surf noise produced by waves breaking on shore; precipitation noise from rain and hail; biological noise from marine mammals, fishes, and crustaceans; and noise from distant shipping traffic, volcanoes, and fishing boats (Richardson et al., 1995). Several of these sources may contribute significantly to the total ambient noise at any one place and time, though ambient noise levels are usually dominated by wind and wave noise. Consequently, ambient noise levels at a given frequency and location may vary widely on a daily basis. A wider range of ambient noise levels occurs in water depths less than 200 m (shallow water) than in deep water. Ambient noise levels in shallow waters are directly related to wind speed and indirectly to sea state. The noise increases with increasing wind and wave height (Wille and Geyer, 1984). Bottom conditions also have a strong effect on shallow-water ambient noise, with generally higher levels of ambient noise where the bottom is very reflective and lower where it is absorptive (Urick, 1983). Volcanic and tectonic noise generated by earthquakes on land or in water propagates as low-frequency, locally generated "T phase" waves. The sounds are usually transient, and the energy levels are generally below 100 Hz (Richardson et al., 1995). Biological noise from fishes, certain shrimps (Myrberg, 1978; Dahlheim, 1987; Cato, 1992), and marine mammals can produce sounds at frequencies ranging from approximately 12 Hz to over 100,000 Hz (Richardson et al., 1995). Ambient noise levels off western Florida are strongly affected by shrimp, the shrimp noise increasing with decreasing water depth (Richardson et al., 1991). Ship traffic is a major source of low-frequency ambient noise in the deep ocean (frequencies from 10 Hz to 200 Hz). In coastal regions, the aggregate noise from many distant fishing vessels may contribute significant sound. Because fishing boats have higher speed engines and propellers than occur on ships, noise spectra from fishing boats peak around 300 Hz (Richardson et al., 1991).

The ambient noise level often determines whether or not an animal can detect a specific sound (man-made or otherwise). If the sound from an industrial source is substantially less intense than the background noise level, the manmade noise cannot be detected, and therefore cannot affect the animal. Any manmade noise strong enough to be audible (detectable above natural background noise) will increase the total background noise (natural plus manmade). Sources of manmade noise in the Gulf of Mexico include transportation, dredging, construction, hydrocarbon and mineral exploration, geophysical surveys, sonars, explosions, and ocean science studies. Noise levels from most human activities are greatest at relatively low frequencies (less than 500 Hz). Several manmade noise sources may contribute to the total noise at any one place and time (Richardson et al., 1995).

Within the Gulf of Mexico, transportation-derived noise sources include aircraft (both helicopters and fixed-wing aircraft) and surface and subsurface vessels. Helicopters account for most offshore flights associated with oil and gas development. Fixed-wing aircraft are primarily used for reconnaissance and to bring personnel and gear to coastal airstrips near drilling or production operations. Underwater sounds from passing aircraft are transient. The primary sources of aircraft noise are their engine(s) (either reciprocating or turbine) and rotating rotors or propellers. Sound levels from both helicopters and fixed-wing aircraft are at relatively low frequencies (usually below 500 Hz) and are dominated by harmonics associated with the rotating propellers and rotors (Smith, 1989; Hubbard, 1995). The propagation and levels of underwater noise from passing aircraft is influenced by the altitude and incident angle of the aircraft, water depth, sound receiver depth, bottom conditions, source duration, and aircraft size and type. Peak received noise level in the water as an aircraft passes overhead decreases with increasing altitude and increasing receiver depth. At incident angles greater than 13° from the vertical, much of the incident noise from passing aircraft is reflected and does not penetrate the water (Urick, 1972). As mentioned previously, bottom type may strongly affect the reflectivity or absorption of sound. The duration of sound from a passing aircraft is variable, depending on the aircraft type, direction of travel, receiver depth, and altitude of the source (Greene, 1985). Large, multiengine aircraft tend to be noisier than small aircraft. Helicopters are typically noisier and produce a larger number of acoustic tones and higher broadband noise levels than fixed-wing aircraft of similar size.

Vessels are the greatest contributor to overall noise in the sea. Small vessels, classified as boats (such as work boats, tugboats, and crew boats), are used in the petroleum industry to ferry work crews and small supplies to offshore sites. Sound levels and frequency characteristics of vessel noises underwater are generally related to vessel size and speed. Large vessels (such as exploration ships, freighters, and tankers) generally emit more sound than small vessels, and those underway with a full load, or those pushing or towing a load, are noisier than unladen vessels. The primary sources of sounds from all machine-powered vessels are related to their machinery and rotating propellers. The frequency of propeller sounds is inversely related to their size. Propeller cavitation is usually the dominant underwater noise source of many vessels (Ross, 1976). Propeller "singing," typically a result of resonant vibration of the propeller blade(s), is an additional source of propeller noise. Noise from propulsion machinery is generated by engines, transmissions, rotating propeller shafts, and mechanical friction. These sources reach the water through the vessel hull. Other sources of vessel noise include a diverse array of auxiliary machinery, flow noise from water dragging along a vessel's hull, and bubbles breaking in the vessel's wake.

Marine dredging and construction activities are common within the coastal waters of the Gulf of Mexico. Underwater noises from dredge vessels are typically continuous in duration (for periods of days or weeks at a time) and are strongest at low frequencies. Marine dredging sound levels vary greatly, depending upon the type of dredge (Greene, 1985, 1987). Sounds from various onshore construction activities vary greatly in levels and characteristics. These sounds are most likely within shallow water. Onshore construction activities may also propagate into coastal waters, depending upon the source and ground material (Richardson et al., 1995).

Offshore drilling and production involves a variety of activities that produce a suite of underwater noises. Noises emanating from drilling activities at fixed, metal-legged platforms are not considered very intense and generally occur at very low frequencies, near 5 Hz. Noise from semisubmersible platforms also show rather low sound source levels. Drillships show somewhat higher noise levels than semisubmersibles as a result of mechanical noises generated through the drillship hull. Noises associated with offshore oil and gas production are generally weak and are typically at very low frequencies (~4.5 to 38 Hz) (Gales, 1982).

Marine geophysical (seismic) surveys are commonly conducted to prospect for oil reservoirs below the surface of the land and seafloor. These operations direct high-intensity, low-frequency sound waves, in short duration pulses, through layers of subsurface rock, which are reflected at boundaries between geological layers with different physical and chemical properties. The reflected sound waves are recorded and processed to provide information about the structure and composition of subsurface geological formations (McCauley, 1994). In an offshore seismic survey, a high-energy sound source is towed at a slow speed behind a survey vessel. The sound source typically used is an airgun (chamber sizes range from 20 to 380 cubic inches), a pneumatic device that produces acoustic output through the rapid release of a volume of compressed air. The airgun is designed to direct the high-energy bursts of low-frequency sound (termed a "shot") downward towards the seafloor. Generally, the published source levels are no more than 240 dB re (at) 1 micropascal (μPa) at 1 m.

For deep surveys, most emitted energy is at 10 Hz to 120 Hz. Airguns are usually used in sets, or arrays, rather than singly (McCauley, 1994). Reflected sounds from below the seafloor are received by an array of sensitive hydrophones on cables (collectively termed "streamers") that are either towed behind a survey vessel or an array attached to cables placed on or anchored to the seafloor.

Active sonars are used for the detection of objects underwater. Sonars emit transient sounds that vary widely in intensity and frequency. These range from depth-finding sonars (fathometers), found on most ships and boats, to powerful and sophisticated units used by the military. Deep tow side-scan sonar surveys are conducted in the Gulf of Mexico primarily for engineering studies involving the placement of production facilities. The sonar device emits a 100 kilohertz (kHz) pulse with an intensity of 10 kilowatts. Unlike most other manmade noises, sonar sounds are mainly at moderate to high frequencies (Richardson et al., 1995).

Underwater explosions in open waters are the strongest point sources of anthropogenic sound in the Gulf of Mexico. Sources of explosions include both military testing and nonmilitary activities such as offshore structure removals. Explosives produce rapid onset pulses (shock waves) that change to conventional acoustic pulses as they propagate (Richardson et al., 1995).

3.1.2. Biological Environment

3.1.2.1. Marine Mammals

Twenty-nine species of marine mammals are known to occur in the Gulf of Mexico (Table 3-1). There are 28 species of the Order Cetacea, which include 7 mysticete species (i.e., baleen whales) and 21 odontocete species (i.e., toothed whales and dolphins). There is also one species of the Order Sirenia, the West Indian manatee (Jefferson et al., 1992; Würsig et al., 2000).

The following discussions on the population status of Gulf of Mexico marine mammals use the following categories adapted from Würsig et al. (2000):

- Common: a species that is abundant and widespread throughout the region where it occurs.
- Uncommon: a species that does not occur in large numbers, and may or may not be widely distributed throughout the region where it occurs.
- Rare: a species present in such small numbers throughout the region where it is seldom seen.
- Extralimital: a species known on the basis of few records that are probably the result of unusual movements of few individuals into the region.

3.1.2.1.1. Threatened or Endangered Species

Five mysticetes (northern right whale, blue whale, fin whale, sei whale, and humpback whale), one odontocete (sperm whale), and one sirenian (the West Indian manatee) that occur or have been reported in the Gulf of Mexico are currently listed as endangered under the provisions of the Endangered Species Act (ESA) of 1973. The five endangered mysticetes are considered rare or extralimital in the Gulf of Mexico (Jefferson, 1995; Jefferson and Schiro, 1997).

Sperm Whale (*Physeter macrocephalus*)

The sperm whale is the only common endangered whale occurring in the Gulf of Mexico (Jefferson, 1995; Jefferson and Schiro, 1997) and is perhaps a resident species offshore of the mouth of the Mississippi River (Davis et al., 2000). It is the largest toothed whale and is distributed from the tropics to polar zones in both hemispheres. Sperm whales are deep diving mammals and inhabit oceanic waters, although they may come close to shore in certain areas where deep water approaches the coast. Sperm whales are known to feed on cephalopods, demersal fishes, and benthic invertebrates (Rice, 1989; Jefferson et al., 1993). Sightings data suggest a Gulfwide distribution on the slope. Congregations of sperm whales are common along the shelf edge in the vicinity of the Mississippi River Delta in water depths of 500-2,000 m. From these consistent sightings it is believed that there is a resident population of sperm whales in the Gulf consisting of adult females, calves, and immature individuals (Brandon and Fargion, 1993; Mullin et al., 1994; Sparks et al., 1996; Jefferson and Schiro, 1997). A recent minimum population estimate of sperm whales in the Gulf of Mexico totaled 411 individuals (Waring et al., 1997). No critical habitat has been designated for the sperm whale in the Gulf of Mexico.

West Indian Manatee (*Trichechus manatus*)

The West Indian manatee inhabits coastal marine, brackish, and freshwater habitats from Virginia to Brazil, including the Greater and Lesser Antilles. It is considered rare in the offshore waters of the Gulf of Mexico. Its distribution in the northern Gulf of Mexico is primarily in peninsular Florida, though individuals may range as far west as Texas (Figure 3-6). Migrations of manatees into areas outside of Florida are seasonal, with recent sightings along the coasts of Alabama, Mississippi, Louisiana, and Texas from March through December (B. Brooks, pers. commun., 2000). Manatees are exclusively herbivorous, feeding on both submergent and emergent aquatic vegetation (Wursig et al., 2000).

The West Indian manatee has two critical habitats in the Gulf of Mexico: Crystal River and southwest Florida from around Tampa Bay south to the southwestern tip of the State (USDOI, Fish and Wildlife Service [FWS], 1996). In addition, nearshore areas from Crystal River to Apalachicola, and from Sarasota south to the southwestern tip of Florida, are identified as migratory routes for West Indian manatees.

3.1.2.1.2. Nonendangered Species

Two mysticete species and 20 species of odontocetes that may inhabit the Gulf of Mexico are not listed as threatened or endangered (Table 3-1).

The two mysticetes are Bryde’s whale and minke whale. Bryde’s whale is the most frequently sighted mysticete in the Gulf, though considered uncommon. Strandings and sightings data suggest that this species may be present throughout the year, generally in the northeastern Gulf near the 100-m isobath between the Mississippi River Delta and southern Florida (Davis et al., 2000; Würsig et al., 2000). The minke whale, on the other hand, is considered extralimital or rare in the Gulf (Würsig et al., 2000).

Most of the odontocetes are considered common in the Gulf. Dwarf and pygmy sperm whales are, however, considered uncommon. The frequency of occurrence of both beaked whales and dwarf and pygmy sperm whales are most likely underestimated because these “cryptic” species are submerged much of the time and avoid aircraft and ships (Würsig et al., 1998). Beaked whales may be uncommon or common rather than rare or extralimital. Their population status is uncertain because they are difficult to see and identify, and most surveys have been conducted in sea states that are not optimal for sighting beaked whales.

According to Waring et al. (1997, 1999), the most abundant cetacean within the Gulf of Mexico is the bottlenose dolphin. Based on systematic surveys conducted during the mid- to late 1990's (i.e., GulfCet II), bottlenose dolphins and Atlantic spotted dolphins were the most commonly sighted cetaceans on the continental shelf (in terms of numbers of individual sightings). On the continental slope, the most commonly sighted cetaceans included bottlenose dolphins (pelagic form), pantropical spotted dolphins, Risso's dolphins, and dwarf/pygmy sperm whales. The most abundant species on the slope (in terms of numbers of individuals) were pantropical spotted dolphins and spinner dolphins (Davis et al., 2000).

Bottlenose Dolphin (*Tursiops truncatus*)

Bottlenose dolphins in the western Atlantic range from Nova Scotia to Venezuela, as well as the waters of the Gulf of Mexico (Blaylock et al., 1995). This species is distributed worldwide in temperate and tropical inshore waters. During GulfCet II aerial and shipboard surveys in the northern Gulf of Mexico, bottlenose dolphins were the most abundant cetacean on the continental shelf and were sighted during all seasons (Mullin and Hoggard, 2000). Water depths of sightings ranged from 30 to 702 m.

Bottlenose dolphins along the U.S. coastline are believed to be organized into local populations, each occupying a small region of the coast, with some migration to and from inshore and offshore waters (Schmidly, 1981). The USDOC, National Marine Fisheries Service [NMFS], recognizes several stocks of bottlenose dolphins in the northern Gulf of Mexico including an OCS stock; a continental shelf edge and continental slope stock; western, northern, and eastern Gulf of Mexico coastal stocks; and a Gulf of Mexico bay, sound, and estuarine stock (Blaylock et al., 1995).

Bottlenose dolphins feed on a variety of fishes, mollusks, and arthropods. Mating and calving occur from February to May. Gestation lasts about 12 months, and the calving interval is 2 to 3 years (Schmidly, 1981). They are found in groups of up to several hundred individuals, with group sizes decreasing with distance from shore.

Atlantic Spotted Dolphin (*Stenella frontalis*)

Atlantic spotted dolphins are widely distributed in warm temperate and tropical waters of the Atlantic Ocean, including the Gulf of Mexico (Perrin et al., 1987, 1994). In the northern Gulf, these animals occur mainly on the continental shelf (Jefferson and Schiro, 1997). During GulfCet II aerial and shipboard surveys in the northern Gulf of Mexico, Atlantic spotted dolphins were seen at water depths ranging from 22 m to 222 m (Mullin and Hoggard, 2000). On the shelf, they were second in abundance after bottlenose dolphins. Atlantic spotted dolphins can be expected to occur on the continental shelf during all seasons. However, they may be more common during spring (Jefferson and Schiro, 1997; Mullin and Hoggard, 2000).

The favored prey of Atlantic spotted dolphins include herrings, anchovies, and carangid fishes (Schmidly, 1981). Mating has been observed in July, with calves born offshore. Atlantic spotted dolphins often occur in groups of up to 50 individuals.

3.1.2.1.3. Factors Influencing Cetacean Distribution and Abundance

The distribution and abundance of cetaceans within the northern Gulf of Mexico is strongly influenced by various mesoscale oceanographic circulation patterns. These patterns are primarily driven by river discharge (primarily the Mississippi/Atchafalaya Rivers), wind stress, and the Loop

Current and its derived circulation phenomena (see Figure 3-4). Circulation on the continental shelf is largely wind-driven, with localized effects from freshwater (i.e., river) discharge. Beyond the shelf, mesoscale circulation is largely driven by the Loop Current in the eastern Gulf. Approximately once or twice a year, the Loop Current sheds anticyclonic eddies (also called warm-core rings). Anticyclones are long-lived, dynamic features that generally migrate westward and transport large quantities of high-salinity, nutrient-poor water across the near-surface waters of the northern Gulf. These anticyclones, in turn, spawn cyclonic eddies (also called cold-core rings) during interaction with one another and upon contact with topographic features of the continental slope and shelf edge. These cyclones contain and maintain high concentrations of nutrients and stimulate localized production (Davis et al., 2000). In the north-central Gulf, the relatively narrow continental shelf south of the Mississippi River Delta may be an additional factor affecting cetacean distribution (Davis et al., 2000). Outflow from the Mississippi River mouth transports large volumes of low salinity, nutrient-rich water southward across the continental shelf and over the slope. River outflow also may be entrained within the confluence of a cyclone-anticyclone eddy pair and transported beyond the continental slope. In either case, this input of nutrient-rich water leads to a localized deepwater environment with enhanced productivity, and may explain the presence of a resident population of sperm whales within 50 km of the Mississippi River Delta in the vicinity of the Mississippi Canyon.

3.1.2.1.4. Acoustic Sensitivity

Some information on the hearing capabilities of small odontocetes (e.g., dolphins) is available from research with captive animals. Detailed audiograms are not available for mysticetes, but their hearing range has been inferred by assuming that they can hear the range of sounds they produce (Richardson et al., 1995).

Odontocetes are most sensitive to high-frequency sounds, e.g., frequencies above approximately 10 kHz. Below that level, sensitivity deteriorates with decreasing frequency; with the possible exception of the sperm whale (Carder and Ridgway, 1990). The sensitivity of many toothed whale species to high frequency sounds is attributed to their use of high frequency sound pulses in echolocation and moderately high frequency calls for communication. Low frequency hearing has not been studied extensively in odontocetes, but some species can detect sound frequencies as low as 60-105 Hz. Below 1 kHz, where most industrial noise energy is concentrated, odontocete hearing sensitivity appears to be relatively poor. In contrast with mysticetes, there is relatively little information about behavioral responses of odontocetes to low frequency noise (Richardson et al., 1995).

Mysticetes apparently are more dependent on low frequency sounds than are odontocetes. Recordings of sounds produced by mysticete whales range from moans at frequencies as low as 12 Hz to clicks at frequencies of up to 31 kHz. Mysticete sensitivity to low frequency noise is also indicated by documented behavioral responses to low frequency sound sources such as seismic airguns (Richardson et al., 1995).

The hearing sensitivity of the West Indian manatee ranges from 15 Hz to 46 kHz, with best sensitivity between 6 kHz and 20 kHz (Gerstein et al., 1999). The USDOI, FWS (1996), indicates that the West Indian manatee is sensitive to low frequency noise.

3.1.2.2. Terrestrial Mammals

This section focuses on endangered terrestrial mammals likely to be present in coastal habitats of the northern Gulf of Mexico, though numerous other terrestrial mammals may be present in coastal habitats at any given time.

Four endangered Gulf coast "beach mice" subspecies, including the Alabama, Choctawhatchee, St. Andrew, and Perdido Key forms, occupy restricted habitats within mature coastal dune habitats of northwestern Florida and Alabama. These beach mice are recognized subspecies of the old-field mouse (*Peromyscus polionotus*) (Bowen, 1968; USDOI, FWS, 1987; Holler, 1992).

Distributions of the four beach mouse subspecies are shown in Figure 3-6. The Alabama beach mouse may be found in Alabama, within disjunct private holdings and a coastal strand habitat within the Bon Secour National Wildlife Refuge (Baldwin County). The Choctawhatchee beach mouse may be found in Florida, within the Topsail Hill State Preserve; on and adjacent to Grayton Beach State Recreation Area in Walton County; and on Shell Island in Bay County (Novak, 1997). The St. Andrew subspecies is the easternmost of the four Gulf coast subspecies, with its current range limited to Florida, within a portion of the St. Joseph Peninsula in Gulf County and East Crooked Island in Bay County (James, 1992). The Perdido Key beach mouse has been extirpated from Alabama but may be found in Escambia County, Florida (Humphrey and Barbour, 1981).

Beach mouse habitat is restricted to mature coastal barrier sand dunes. The inland extent of the habitat may vary depending on the configuration of the sand dune system and the vegetation present. Along the Gulf Coast, there are commonly several rows of dunes paralleling the shoreline; within these rows, there are generally three types of microhabitat. Beach mice dig burrows mainly on the lee side of the primary dunes and in other secondary and interior dunes where the vegetation provides suitable cover (Blair, 1951). The mice may also use ghost crab (*Ocypoda quadratus*) burrows. Beach mice typically feed nocturnally in the dunes and remain in burrows during the day. Their diets vary seasonally but consist mainly of seeds, fruits, and insects (Moyers, 1996).

All four beach mouse subspecies are federally listed as endangered as a result of the loss and degradation of the aforementioned coastal dune habitats due to coastal development. The combination of habitat loss and fragmentation resulting from beachfront development, the subsequent isolation of remaining habitat fragments and beach mouse populations, and destruction of these remaining habitats by hurricanes has increased the threat of extinction of these subspecies (Moyers et al., 1996; Holler et al., 1999). Conservation measures have resulted in the identification of several key areas as critical habitats for the Alabama, Choctawhatchee, and Perdido Key forms. Critical habitat has not been designated for the St. Andrew beach mouse.

The Florida salt marsh vole (*Microtus pennsylvanicus dukecampbelli*) is a small (less than 20 cm) rodent that is closely related to the meadow vole (Woods et al., 1982). It is known only from one site at Waccasassa Bay in Levy County, Florida, where it appears to exist in low numbers (Figure 3-6). Its habitat is a Gulf Coast salt marsh where it probably feeds mainly on green plant materials, especially grasses. The Florida salt marsh vole appears to be most common in areas vegetated by salt grass (*Distichlis spicata*). It is believed to survive high tides and storm flooding by swimming and climbing vegetation. Due to the very restricted range of this subspecies, any natural or human-caused adverse impact could result in its extinction.

3.1.2.3. Marine and Coastal Birds

The waters and adjacent coastal landforms of the northern Gulf of Mexico are inhabited by a diverse assemblage of resident and migratory birds (Lowery, 1955; Imhof, 1976; Clapp et al., 1982a, b, and c; Kale and Maehr, 1990; Rappole and Blacklock, 1994; National Geographic Society, 1999). The aquatic and semiaquatic species may be roughly categorized into four groups: seabirds, shorebirds, wetland birds, and waterfowl. Table 3-2 lists coastal and marine birds within these four groups. The Gulf of Mexico is also seasonally traversed by a taxonomically diverse and sizeable array of migrant terrestrial bird species.

3.1.2.3.1. Threatened or Endangered Species

Most of the threatened or endangered species of coastal and marine birds that occur in the Gulf of Mexico inhabit or frequent only coastal areas and waters of the inner continental shelf (USDOI, FWS, 1998c). Species or species of concern (i.e., a candidate for Federal listing under the ESA) that have been identified by USDOI, FWS, as potentially sensitive to OCS activities within the Gulf of Mexico are briefly described below.

Southern Bald Eagle (*Haliaeetus leucocephalus leucocephalus*)

The southern bald eagle is a terrestrial raptor that is widely distributed across the southern United States, including coastal habitats along the Gulf of Mexico. The Gulf coast is inhabited by both wintering migrant and resident bald eagles (Johnsgard, 1990; Ehrlich et al., 1992). Although populations of southern bald eagles have increased in recent years as a result of the ban of DDT pesticide and the efforts of intense recovery programs, it is currently listed as threatened.

Eastern Brown Pelican (*Pelicanus occidentalis carolinensis*)

The eastern brown pelican is one of two pelican species occurring in North America. It inhabits coastal habitats and forages within coastal waters and waters of the inner continental shelf, typically less than 32 km from the coast. Subsequent to the ban of DDT, this species has successfully recolonized much of its former range and has been delisted from its endangered status in all States except for Mississippi and Texas (Ehrlich et al., 1992).

Eskimo Curlew (*Nominees borealis*)

The Eskimo curlew is a migrant shorebird that nests in wetlands of open tundra within the high arctic and overwinters within southern South America, primarily Argentina. This species currently remains listed as endangered, though it may be extinct, primarily as a result of extensive hunting pressure (Ehrlich et al., 1992). Most sightings of this species over the last century have been along the Texas coast during the spring (National Geographic Society, 1999).

Piping Plover (*Charadrius melodus*)

The piping plover is a migrant shorebird that overwinters along the Gulf of Mexico and southeastern U.S. coasts. Piping plovers inhabit coastal sandy beaches and mudflats. This species is currently in decline and listed as endangered as a result of historic hunting pressure, and habitat loss and degradation (Ehrlich et al., 1992).

Southeastern Snowy Plover (*Charadrius alexandrinus tenuirostris*)

The southeastern snowy plover is a shorebird that nests within such Gulf of Mexico coastal habitats as dry sandy beaches and flats. It is listed as a species of concern by the USDOI, FWS, because of population declines resulting from habitat loss and degradation (Ehrlich et al., 1992).

Roseate Tern (*Sterna dougallii*)

The roseate tern is a seabird that commonly ventures into oceanic waters; however, its western Atlantic population is known to only approach the far southeastern Gulf to breed in scattered colonies along the Florida Keys (Ehrlich et al., 1992). It is currently listed as threatened in Florida.

Whooping Crane (*Grus americana*)

The whooping crane is a migrant wetland bird that nests within western Canada and the north-central United States, and overwinters on salt flats and wetlands habitats along the Aransas National Wildlife Refuge on the Texas coast (Johnsgard, 1983; Ehrlich et al., 1992). It is currently listed as endangered due to historic hunting pressure and habitat loss and degradation (Doughty, 1989).

Wood Stork (*Mycteria americana*)

The wood stork is the only stork (Family Ciconiidae) that regularly inhabits North America. This wading bird is a year-round resident of Florida and Georgia, though sightings occur within other Gulf coastal States. Wood storks frequent freshwater and brackish coastal wetland habitats (Ehrlich et al., 1992), and it is currently listed as endangered.

3.1.2.3.2. Nonendangered Species

Five taxonomic orders of seabirds (broadly defined as those species that spend a large portion of their lives on or over seawater) are found in both offshore and coastal waters of the Gulf of Mexico. Some species of this group inhabit only pelagic habitats in the Gulf (OCS and beyond) (e.g., boobies, petrels, and shearwaters). Most Gulf seabird species, however, inhabit waters of the continental shelf and adjacent coastal and inshore habitats (Clapp et al., 1982a; Harrison, 1983, 1996; Bent, 1986; Warham, 1990; Peake et al., 1995; Olsen and Larsson, 1995, 1997; National Geographic Society, 1999). Gulf of Mexico seabirds were categorized by Fritts and Reynolds (1981) as summer migrant pelagics, summer residents, wintering marine species, or permanent residents. Summer migrant pelagic species are those that are present in the Gulf during the summer but breed primarily elsewhere. Examples include black terns, boobies, shearwaters, storm-petrels, and tropic birds. Summer residents are those which are present during summer months but also breed in the Gulf. Examples include least terns, sandwich terns, and sooty terns. Wintering marine bird species are those which may be found in the Gulf only during winter months. Examples of wintering species include herring gulls, jaegers, and the northern gannet. Permanent resident species are found in the Gulf year-round. Examples of permanent residents include bridled terns, laughing gulls, magnificent frigate birds, and royal terns.

Shorebirds include members of the Order Charadriiformes that, outside of their migratory cycles, are generally restricted to coastline margins. Shorebirds are among the world's greatest migratory animals. Many North American shorebirds seasonally traverse between the high arctic and South America, and occasionally spill over into Asia and Europe (Bent, 1962a, b; Hayman et al., 1986). Certain coastal and adjacent inland wetland habitats of the Gulf of Mexico serve as vital overwintering habitats and temporary "staging" habitats for shorebirds. Staging birds (those migrant species that reside temporarily along the Gulf coast) forage within coastal habitats in an effort to accumulate energy reserves necessary for the completion of their migratory efforts (Hayman et al., 1986). Many shorebird species typically aggregate in large numbers within Gulf coastal habitats. In addition, many of the overwintering shorebird species remain within specific areas throughout the season and exhibit between-year wintering site tenacity, making these species especially susceptible to localized impacts resulting in habitat loss or degradation.

The wetland bird group includes a diverse array of birds that typically inhabit most Gulf Coast aquatic habitats ranging from freshwater swamps and waterways to brackish and saltwater wetlands and embayments. Many wetland birds are commonly year-round residents on the Gulf of Mexico coastal areas. They exhibit diverse feeding strategies, both in terms of methods (and thus selected prey) and period (including both diurnal and crepuscular feeders) (Krebs, 1978; Kushlan, 1978; Hancock and Kushlan, 1984; Bildstein, 1993; Taylor, 1998; Weller, 1999).

Waterfowl are members of the Order Anseriformes that inhabit freshwater and marine aquatic habitats. Many of these birds are migrant species that, primarily during winter months, inhabit coastal waters, beaches, flats, sandbars, and wetland habitats along the Gulf of Mexico (Madge and Burns, 1988; Weller, 1988).

The Gulf of Mexico is an important pathway for migratory birds, including many coastal and marine species, and large numbers of terrestrial species. Most of the migrant birds (especially passerines or perching birds) that overwinter in the neotropics (tropical Central America and South America) and breed in eastern North America either directly cross the Gulf of Mexico (trans-Gulf migration) or move north or south by traversing the Gulf coast or the Florida peninsula (Berthold, 1993; DeGraaf and Rappole, 1995; Rappole, 1995; Stotz et al., 1996). Florida migrants then either cross to the Bahamas Archipelago or travel directly across the Florida Straits and into the Antilles (Hagan and Johnston, 1992). Recent studies indicate that the flight pathways of the majority of the trans-Gulf migrant birds during spring are directed toward the coastlines of Louisiana and eastern Texas. During overwater flights, migrant birds (other than seabirds) commonly use offshore oil and gas production platforms for rest stops or as temporary shelter from inclement weather. Thus it is believed that these platforms may serve as artificial islands for these species during their migrations (R. Russell, Louisiana State University Museum of Natural History, pers. commun., 1999).

3.1.2.4. Fish Resources

3.1.2.4.1. Threatened or Endangered Species

Gulf Sturgeon (*Acipenser oxyrinchus desotoi*)

The Gulf sturgeon is a geographic subspecies of the Atlantic sturgeon. The disjunct distribution of the Atlantic sturgeon is due to zoogeographic and life-history patterns. Sturgeons require freshwater rivers for spawning. Because there are no adequate riverine habitats in southern Florida, this portion of the peninsula acts as a barrier to interchange between the Atlantic and Gulf of Mexico stocks (Bowen and Avise, 1990).

The Gulf sturgeon is an anadromous fish that migrates from the sea upstream into coastal rivers to spawn in freshwater. Historically, it ranged from the Mississippi River to Charlotte Harbor, Florida; today, this range has contracted to encompass major rivers and inner shelf waters from the Mississippi River to the Suwannee River, Florida. Populations have been depleted or driven to extinction throughout this range by fishing, shoreline development, dam construction, water quality, and other factors (Barkuloo, 1988). These declines prompted the listing of the Gulf sturgeon as a threatened species in 1991. Subsequently, a recovery plan was developed to ensure the preservation and protection of Gulf sturgeon spawning habitat (USDOI, FWS, and Gulf States Marine Fisheries Commission, 1995). The best known populations occur in the Apalachicola and Suwannee Rivers in Florida (Carr, 1996; Sulak and Clugston, 1998), the Choctawhatchee River in Alabama (Fox et al., 2000), and the Pearl River in Mississippi/Louisiana (Morrow et al., 1998). The largest existing population is thought to be in Florida's Suwannee River (Gilbert, 1992). Genetic studies show that the populations among different rivers are fairly distinct and that the Gulf sturgeon may even be river specific (Stabile et al., 1996). Inner shelf areas and river systems where Gulf sturgeon occur are illustrated in Figure 3-7.

Most of the relevant ecological information on Gulf sturgeon comes from studies conducted on the Suwannee River population. Females reach sexual maturity between 8 and 17 years, whereas males reach sexual maturity between 7 and 21 years (Huff, 1975). Spawning occurs from March to May with a peak in April (Huff, 1975; Sulak and Clugston, 1998; Fox et al., 2000). Females lay large numbers of eggs (> 3 million) in freshwater reaches of rivers, usually in deep areas or holes with hard bottoms and where some current is present (Sulak and Clugston, 1998; Fox et al., 2000). Eggs are adhesive and will attach to rocks, vegetation, or other objects. These eggs hatch in about 1 week depending upon temperature of the water. The young fish remain in freshwater reaches of the rivers for about 2 years then begin to migrate back downstream to feed in estuarine and marine waters. The adults spend March through October in the rivers and November through February in estuarine or shelf waters. Upstream and downstream migrations appear to be triggered by changes in water temperature. While in the riverine environment, the young feed upon larger planktonic organisms (crustaceans and insect larvae), and adults feed on clams and snails. Near the river mouths and on the inner continental shelf, adults continue to feed upon clams and snails but include other items in their diet such as crabs, shrimps, worms, brachiopods, amphipods, isopods, and small fishes (Gilbert, 1992). The Gulf sturgeon grows to 240 cm in length and can attain an age of 42 years with adult females being larger than males. These life history attributes, particularly slow growth and late age of maturity, contribute to the Gulf sturgeon's vulnerability (Huff, 1975).

3.1.2.4.2. Nonendangered Species

Other Fish Resources – Continental Shelf

The Gulf's marine habitats, ranging from coastal marshes to the deep-sea abyssal plain, support a varied and abundant fish fauna. Distinctive fish assemblages can be recognized within broad habitat classes for the continental shelf and oceanic waters (Table 3-3) as follows: soft-bottom fishes, hard-bottom fishes, and coastal pelagic fishes on the continental shelf; and epipelagic fishes, midwater fishes, and demersal fishes in oceanic waters (> 200-m water depths).

Soft-Bottom Fishes: The bottom-oriented or demersal shelf fish fauna can be generally characterized by substrate composition and water depth. Chittenden and McEachran (1976); Darnell et al. (1983); and Darnell and Kleypas (1987) have described this fauna in detail. From the Rio Grande to the Florida Keys, a total of 372 demersal fishes were recorded (Darnell and Kleypas, 1987). Of these, 164 occurred in the northwestern Gulf and 347 in the northeastern Gulf. While some species are widespread, the number of species is much higher in the northeastern Gulf of Mexico. Sediment composition, rainfall, river discharge, and isolation all contribute to these observed patterns. Coastal estuaries may also play a significant role in the promotion of high species diversity (Cunningham, Saigo, 1999). They are significant "nurseries" and provide diverse habitat for juvenile fish and crustaceans. As with the common shrimp species of the Gulf, soft bottom fishes generally prefer certain types of sediments over others. This tendency led to the naming of three primary fish assemblages by the dominant shrimp species found in the same sediment/depth regime.

These assemblages are as follows:

- Pink shrimp assemblage (carbonate sediments, east of De Soto Canyon, 10-41 m);
- White shrimp assemblage (fine sediments, west of De Soto Canyon, 3.5-22 m);
- Brown shrimp assemblage (coarse sediments, west of De Soto Canyon, 22-91 m).

Common members of the pink shrimp assemblage include Atlantic bumper, sand perch, silver jenny, dusky flounder, and pigfish. This assemblage occurs on the west Florida shelf. Longspine porgy, leopard sea robin, horned sea robin, and dwarf goatfish characterize the brown shrimp assemblage. Most of these species spend their entire life cycle in marine waters. The white shrimp assemblage consists of species such as Atlantic croaker, star drum, Atlantic cutlassfish, sand sea trout, silver sea trout, Atlantic threadfin, and hardhead catfish. Most of these species spawn in shelf waters and spend their early life stages in estuarine waters.

In some areas offshore of west Florida, particularly the Big Bend area and Florida Bay, soft bottom areas are vegetated with seagrasses and macroalgae. These vegetated bottoms support numerous fishes including red drum, pinfish, spotted sea trout, filefishes, and spot. Both adults and juveniles of these species utilize the vegetated habitats (Gulf of Mexico Fishery Management Council, [GMFMC], 1998).

Hard-Bottom Fishes: Another important habitat for fishes on the continental shelf is the hard bottom. The term hard bottom generally refers to exposed rock, but can refer to other substrata such as coral and clay, or even artificial structures. The estimated areal extent of natural hard bottom in the Gulf of Mexico is 4,772,600 hectares (ha), and 94 percent of this exists on the west Florida shelf from the Dry Tortugas to Pensacola (GMFMC, 1998). Outside of the Florida shelf, hard bottom occurs on the Mississippi-Alabama shelf, the Texas-Louisiana shelf, and the south Texas shelf. Colonized by stony corals, sea whips, sponges, tunicates, and algae, these structures provide shelter, food, and spawning sites for fishes. Fishes found over hard-bottom habitats in middle (50-100 m) and outer (100-200 m) shelf waters include reef and coastal pelagic forms. Reef fishes such as snappers, groupers, grunts, porgies, squirrelfishes, angelfishes, damselfishes, butterflyfishes, surgeonfishes, parrotfishes, and wrasses inhabit hard-bottom habitats in the Gulf of Mexico (Dennis and Bright, 1988). In water depths exceeding 50 m, a distinctive deep-reef assemblage mixes with depth-tolerant members of the shallow reef assemblages. Deep-reef species in the Gulf of Mexico include rough tongue bass, yellowtail reeffish, short bigeye, and wrasse bass. Deep-reef fishes occur on hard-bottom features in water depths of 50-105 m off southwest Florida, the Mississippi-Alabama Pinnacle trend (Brooks, 1991), the Texas-Louisiana shelf edge, and the south Texas carbonate banks (GMFMC, 1998).

Some species utilize the hard-bottom habitat as adults and juveniles, whereas others undergo ontogenetic migrations from adjacent habitats such as seagrass meadows. Some species, such as gag grouper, aggregate to spawn on hard-bottom sites that may be used by the population for many generations (GMFMC, 1998). Other species deposit demersal eggs on the substrate, whereas other species shed eggs and sperm into the water column where they are fertilized and then transported to other areas, often many kilometers from the spawning site.

Artificial hard-bottom sites, including sunken vessels, oil and gas platforms, and other debris, represent 1.3 percent of all hard bottom in the Gulf of Mexico (GMFMC, 1998). Nevertheless, these structures support abundant fish populations in the shelf waters of all Gulf Coast States (GMFMC, 1998).

Coastal Pelagic Fishes: The basic pelagic fish assemblage found in Gulf of Mexico shelf waters is usually termed coastal pelagic. The major coastal pelagic families occurring in the Gulf are requiem sharks, ladyfish, anchovies, herrings, mackerels and tunas, jacks, mullets, bluefish, and cobia. Coastal pelagic species traverse shelf waters of the region throughout the year. Some species form large schools (e.g., Spanish mackerel), while others travel singly or in smaller groups (e.g., cobia). The distribution of most species depends upon water column structure, which varies spatially and seasonally.

King mackerel exist in two populations in the Gulf of Mexico, an eastern group and a western group. The eastern population migrates from near the Mississippi Delta eastward, then southward around the Florida peninsula, wintering off southeastern Florida (Sutter et al., 1991). The western population travels to waters off the Yucatan Peninsula during winter. In summer, both populations migrate to the northern Gulf of Mexico, where they intermix to an unknown extent (Johnson et al., 1994). Spanish mackerel, cobia, bluefish, crevalle jack, and coastal sharks (*Carcharhinus* spp.) are migratory, but their routes have not been studied. Spanish mackerel, bluefish, and crevalle jack generally migrate westward along the shelf in warm months and back eastward towards Florida during cold months (Barry A. Vittor & Associates, Inc., 1985). All of these species are predatory, feeding upon a range of fishes and invertebrates.

Coastal pelagic fishes can be divided into two ecological groups. The first group includes larger predatory species such as king and Spanish mackerels, bluefish, cobia, dolphin, jacks, and little tunny. These species typically form schools, undergo migrations, grow rapidly, mature early, and exhibit high fecundity. Each of these species is important to some extent to regional fisheries. Some of these larger predatory species (particularly bluefish, Spanish mackerel, and blue runner) may be attracted to large concentrations of anchovies, herrings, and silversides that congregate in nearshore areas. The second group exhibits similar life history characteristics, but the species are smaller in body size and are planktivorous. This group is composed of Gulf menhaden, Atlantic thread herring, Spanish sardine, round scad, and anchovies (Saloman and Naughton 1983, 1984; USDOI, MMS, 1999).

Other Fish Resources – Deepwater

Epipelagic Fishes: Epipelagic fishes inhabit the upper 200 m of the water column in oceanic waters beyond the continental shelf edge (Bond, 1996). This group includes several shark species (mako, silky, oceanic whitetip, whale shark), billfishes (marlins, sailfish, and swordfish), herrings, flying fishes, halfbeaks, opahs, oarfishes, bluefish, scads, jacks, pilotfishes, dolphin, remoras, pomfrets, tunas, butterfishes, and tetraodontiform fishes (molas and triggerfishes). A number of these species such as dolphin, sailfish, white marlin, blue marlin, and tunas are important to commercial and recreational fisheries (USDOC, NMFS, 1999). Many of these species such as bluefin tuna and swordfish spawn in the eastern Gulf of Mexico in relation to the Loop Current boundary (USDOI, MMS, 1999) (Figure 3-3). All of the epipelagic species are migratory, but specific patterns are not well understood. Many of the oceanic species associate with flotsam, which provides forage areas and/or nursery refuges.

Floating seaweed (*Sargassum*), jellyfishes, siphonophores, and driftwood attract juvenile and adult epipelagic fishes. Larger predators forage around flotsam. As many as 54 fish species are closely associated with floating *Sargassum* at some point in their life cycle, but only 2 spend their entire lives there: the sargassum fish and the sargassum pipefish (USDOI, MMS, 1999). Most fish associated with *Sargassum* are temporary residents, such as juveniles of species that reside in shelf or coastal waters as adults (USDOI, MMS, 1999). However, several larger species of recreational or commercial importance including dolphinfish, yellowfin tuna, blackfin tuna, skipjack tuna, Atlantic bonito, little tunny, and wahoo feed on the small fishes and invertebrates attracted to *Sargassum* (Morgan et al., 1985; USDOI, MMS, 1999).

Midwater Fishes: Below the epipelagic zone, the water column may be layered into mesopelagic (200-1,000 m) and bathypelagic (>1,000 m) zones. Taken together, these two zones and their inhabitants may be referred to as midwater. In the mesopelagic zone of the Gulf of Mexico, fish assemblages are numerically dominated by lanternfishes, bristlemouths, and hatchetfishes (USDOI, MMS, 1999). Lanternfishes are small silvery fishes that can be extremely abundant, often responsible for the deep scattering layer in sonar images of the deep sea. Lanternfishes and other mesopelagic fishes spend the daytime in depths of 200-1,000 m, but migrate vertically at night into food-rich, nearsurface waters. Mesopelagic fishes, while less commonly known, are important ecologically because they transfer significant amounts of energy between mesopelagic and epipelagic zones over each daily cycle. The lanternfishes are important prey for meso- and epipelagic predators (e.g., tunas), and particularly the mesopelagic dragonfishes (Hopkins et al., 1997).

Deeper dwelling bathypelagic fishes inhabit the water column at depths greater than 1,000 m. This group is composed of strange, little known species such as snipe eels, slickheads, deep-sea anglers, bigscales, and whalefishes (McEachran and Fechhelm, 1998). Most species are capable of producing and emitting light (bioluminescence) to aid communication in an environment devoid of sunlight. Little scientific information is available on bathypelagic fishes of the Gulf of Mexico.

Demersal Fishes: Demersal fishes are those that are either in direct contact with the substrate or hover above it from the shelf-slope transition down to the abyssal plain. The deep-sea demersal fish fauna in the Gulf of Mexico includes about 300 species. The most diverse group is the cod-like fishes such as hakes and grenadiers, followed by eels, cusk-eels, sharks, and flatfishes. Members of these groups were collected during MMS-sponsored demersal sampling programs (Pequegnat, 1983; Gallaway and Kennicutt, 1988). In general, fish species diversity decreases with increasing water depth. The highest diversity and density of demersal fishes was found along the continental slope in the eastern Gulf. Deep-sea demersal fishes consume a wide range of organisms including fishes and epifaunal, infaunal, meiofaunal, and planktonic invertebrates. In general, most fishes lay demersal eggs (Bond, 1996). They may be adhesive and deposited in clumps or stick together through the incubation period, or they may be attached singly to some substrate.

3.1.2.5. Sea Turtles (Threatened or Endangered Species)

Five species of sea turtles, the green, hawksbill, Kemp's ridley, leatherback, and loggerhead, are known to inhabit the Gulf of Mexico (Table 3-4) (Pritchard, 1997). All five are listed as either endangered or threatened species under the ESA (Pritchard, 1997).

The life histories of sea turtles include four developmental stages: embryo, hatchling, juvenile, and adult. Habitat utilization and migrations of sea turtles vary depending upon these specific developmental stages and result in differential distributions (Marquez, 1990; Ackerman, 1997; Hirth, 1997; Musick and Limpus, 1997). Consequently, the degree of sea turtle vulnerability to specific human impacts may also vary between developmental stages. Sea turtle eggs deposited in excavated nests on sandy beaches are especially vulnerable to coastal impacts. Hatchling turtles move immediately from these nests to the sea after hatching and swim offshore. Most species ultimately move into areas of current convergence or to mats of floating *Sargassum*, where they undergo primarily passive migration within oceanic gyre systems. The passive nature of hatchling turtles, along with their small size, make them vulnerable to certain impacts in open-ocean environments. After a period of years (the period of which is species specific), most juvenile turtles (defined as those which have commenced feeding but have not attained sexual maturity) actively recruit to nearshore developmental habitats within tropical and temperate zones. Juvenile turtles in some temperate zones also make seasonal migrations to foraging habitats at higher latitudes in summer months. The movements of turtles in tropical areas are typically more localized. When approaching sexual maturity, juvenile turtles move into adult foraging habitats. Thus, both juvenile and adult sea turtles may be vulnerable to certain impacts in both open-ocean and near coastal environments but (unlike hatchlings) may actively avoid or escape certain impact producing factors. Near the onset of nesting season, adult turtles move between foraging habitats and nesting beaches. Mating may occur directly off the nesting beaches or remotely, depending on the species and population. During the nesting season, the females become resident in the vicinity of the nesting beaches and may be more vulnerable to impacts within these near coastal waters and on nesting beaches.

Sea turtles nest along the entire northern Gulf of Mexico coast. Although, most nesting occurs along the northwest Florida coast and consists of primarily loggerheads, green, leatherback, and a few Kemp's ridley turtles (1-2 reported nests). There are reports of recent nesting in Alabama (loggerhead and green turtles) along Dauphin Island and the Gulf Islands National Seashore; Mississippi (loggerhead turtles) along the Gulf Islands National Seashore; and Louisiana (loggerhead turtles) within the Breton National Wildlife Refuge. Sea turtles also nest along areas of the Texas coast (Padre Island National Seashore), including loggerhead, green, and Kemp's ridley turtles (S. MacPherson, USDOI, FWS, pers. comm., 2000). Hatchling turtles found in the offshore waters of the northern Gulf of Mexico may have originated from these nesting beaches or adjacent areas such as the southern Gulf of Mexico and Caribbean Sea. Juvenile turtles may move into shallow water developmental habitats across the entire northern Gulf. Adult foraging habitats may be, in some species or populations, geographically distinct from their developmental habitats (Musick and Limpus, 1997).

There are no designated critical habitats or migratory routes for sea turtles in the northern Gulf of Mexico. The NMFS does recognize many coastal areas of the Gulf as preferred habitat (i.e., important sensitive habitats that are essential for the species within a specific geographic area), for example, seagrass beds in Texas lagoons and other nearshore or inshore areas (including jetties) for green turtles, and bays and lakes, especially in Louisiana and Texas, for ridleys. *Sargassum* mats are also recognized as preferred habitat for hatchlings.

Green Sea Turtle (*Chelonia mydas*)

Green sea turtles are found throughout the Gulf of Mexico. They occur in small numbers over seagrass beds along the south Texas coast and the Florida Gulf coast. Reports of green turtles nesting along the Gulf of Mexico coast are infrequent, and the closest important nesting aggregations are along the east coast of Florida and the Yucatan Peninsula (USDOC, NMFS, and USDOI, FWS, 1991b).

Hawksbill Sea Turtle (*Eretmochelys imbricata*)

The hawksbill sea turtle has been recorded in all the Gulf of Mexico States (USDOC, NMFS, and USDOI, FWS, 1993). However, sightings north of Florida are rare. The hawksbill is the least common sea turtle in the Gulf of Mexico (Marquez, 1990; Hildebrand, 1995). Hawksbill nesting within the continental United States is limited to southeastern Florida and the Florida Keys.

Kemp's Ridley Sea Turtle (*Lepidochelys kempi*)

The ridley is the smallest of sea turtles. Survey data from the Gulf of Mexico suggest that Kemp's ridley turtles occur mainly on the continental shelf. Juvenile and adult Kemp's ridleys are typically found in shallow coastal areas and especially in areas of seagrass habitat (Marquez, 1990; USDOC, NMFS and USDOI, FWS, 1992b; Ernst et al., 1994). The major nesting area for this species is near Rancho Nuevo, along the northeastern coast of Mexico (Tamaulipas), although scattered nesting has also been reported in other areas of Mexico and Texas, Colombia, Florida, and South Carolina (Ernst et al., 1994). Adult Kemp's ridleys exhibit extensive inter-nesting movements. They appear to also travel near the coast and are especially common within shallow waters along the Louisiana coast.

Leatherback Sea Turtle (*Dermochelys coriacea*)

The leatherback sea turtle is the most abundant turtle on the northern Gulf of Mexico continental slope (Davis et al., 2000). It is the most pelagic and wide-ranging sea turtle, undertaking extensive migrations from the tropics to boreal waters. Leatherback nesting within the continental United States is limited to eastern Florida (USDOC, NMFS, and USDOI, FWS, 1992a; Ernst et al., 1994; Meylan et al., 1995). Leatherbacks appear to spatially use both continental shelf and slope habitats in the Gulf of Mexico (Fritts et al., 1983a,b; Collard, 1990; Davis and Fargion, 1996). Results of MMS-sponsored surveys (i.e., GulfCet I and II) suggest that the region from Mississippi Canyon to De Soto Canyon, especially near the shelf edge, appears to be an important habitat for leatherbacks (Davis et al., 2000). Temporal variability in leatherback distribution and abundance suggest that specific areas may be important to this species, either seasonally or for short periods of time. During the GulfCet I and II programs, leatherbacks were sighted frequently during both summer and winter (Davis et al., 2000).

Loggerhead Sea Turtle (*Caretta caretta*)

The loggerhead sea turtle is the most abundant sea turtle in the Gulf of Mexico (Dodd, 1988). Loggerhead nesting along the Gulf Coast occurs primarily along the Florida Panhandle, although some nesting has also been reported from Texas through Alabama (USDOC, NMFS, and USDOI, FWS, 1991a). Loggerhead turtles have been primarily sighted on the continental shelf, although many sightings of this species have also been made in the deeper slope waters at depths of greater than 1,000 m. Sightings of loggerheads on the continental slope suggest that they may be in transit through these waters to distant foraging sites or while seeking warmer waters during winter. Although loggerheads were widely distributed across the shelf during both summer and winter, their abundance on the slope was greater during winter than summer (Davis et al., 2000).

3.1.2.6. Coastal Habitats

3.1.2.6.1. Coastal Barrier Beaches and Dunes

Coastal barrier landforms of the Gulf of Mexico consist of islands, spits, and beaches that extend in an irregular arch from Collier County, Florida, westward to the U.S./Mexico border in Cameron County, Texas. These elongated, narrow landforms are composed of sand and other unconsolidated coarse sediments that have been transported to their present locations by rivers, waves, currents, storm surges, and winds. Coastal landforms are transitory in nature and are constantly being sculpted and modified by the same forces that led to their original deposition.

Barrier islands and sand spits protect the low-energy coastal habitats located behind them from the direct impacts of the open ocean. By separating coastal waters from the open ocean, these landforms contribute to and increase the amount of available estuarine habitat. They also provide protection for the coastal wetlands, which provide habitat to a large number of bird and other animal species, including several species that are endangered or threatened.

Sea-level rise since the end of the last glacial period, approximately 10,000 years ago, has greatly affected the coastal landforms seen in the Gulf today. Present barrier landforms are relatively young, having been formed between 5,000 and 6,000 years ago when the main continental ice sheets melted and sea-level rise began to stabilize.

The accumulation and movement of the sediments making up barrier islands, sand spits, and beaches are often described in terms of “transgressive” or “regressive” sequences. A transgressive sequence is one in which the shoreline is moving landward and marine deposits rest on top of terrestrial deposits. A regressive sequence is one in which terrestrial sediments are being deposited on top of marine sediments and the shoreline is being extended out into the sea. Transgressive barrier islands are usually undergoing active erosion. They characteristically have a predominately low-profile morphology characterized by narrow widths; low, sparsely vegetated, discontinuous dunes; and numerous active washover channels. Regressive landforms are undergoing accretion or active sediment deposition and characteristically have high-profile morphologies; broad widths; and high, continuous, well-vegetated dunes. Regressive landforms have few, if any, washover channels.

Barrier landforms (i.e., barrier islands, major bars, sand spits) in the Gulf of Mexico are divided into six major groups based on location: (1) the Southwest Florida Barrier Island Landform Complex; (2) the Northwest Florida Barrier Island Landform Complex; (3) the Mississippi Sound Landform Complex; (4) the Mississippi Deltaic Landform Complex; (5) the Chenier Plain Landform Complex; and (6) the Texas Barrier Island Landform Complex. Figure 3-8 identifies the general location of these landform complexes.

The Florida Keys to the south of Florida Bay are unique coastal features not seen elsewhere along the U.S. Gulf of Mexico coast. They form a line of cemented limestone islands, which provide unique habitats for a variety of flora and fauna (USDOI, MMS, 1996).

Along the southwest Florida coastline, barrier-island-type landforms first appear in Collier County, north of Florida Bay and the Everglades. Barrier islands and sandy beaches are seen from Collier County northward through the Anclote Key area of Pasco County. Throughout the Big Bend area east of Cape San Blas, the coast curves inward, away from the Gulf proper. The coastline in this area is one of the lowest energy coastlines in the world (Continental Shelf Associates, Inc. and Martel Laboratories, Inc., 1986). Typical barrier islands and beaches are not seen along this coast, and forested wetlands occur down to the water’s edge. With the exception of the Cedar Keys and the islands near the mouth of the Suwannee River, coastal islands and beaches are not seen throughout the Florida Big Bend area. Barrier islands and sand beaches reappear on the western side of Apalachee Bay (west of Alligator Harbor) and continue on around Cape San Blas and throughout the Florida Panhandle. The barrier islands and mainland beaches of the Florida Panhandle typically are stable, with broad, high-profile beaches backed by high dunes. These beaches are some of the most beautiful seen in the Gulf of Mexico and represent a major economic asset to the State of Florida and the region in general.

On the coast inshore of the Central Gulf of Mexico Planning Area, barrier islands and landforms occur in three settings. From east to west, these settings are: (1) Mississippi Sound barrier islands,

(2) Mississippi River deltaic barrier islands, and (3) barrier islands and beaches of Chenier Plain, Louisiana.

The Mississippi Sound barrier islands have formed over the last 3,000 to 4,000 years as a result of westward sand migration resulting in shoal and sand bar growth (Otvos, 1980). Geologically, these features are quite young. The islands are separated from each other by fairly wide, deep channels. Ebb and flood tide deltas and shoals are associated with these channels and contribute to the sediment budget and sand transfer processes characteristic of this system. All islands within this setting are generally regressive or stable features with high beach ridges and prominent sand dunes. They are well vegetated, showing a southern maritime forest climax community of pine and palmetto. Although some of these islands may experience washover during significant storms, washover channels are not common. Most of these islands show no trend toward erosion or thinning, although they do migrate westward in response to the westward moving longshore current. Dauphin Island is an exception to this generality in that the western end of this island is a long, narrow, transgressive sand deposit, which is frequently overwashed by storms. This portion of the island is apparently migrating toward the mainland.

Louisiana has the most rapidly retreating beaches on the continent. The Statewide average for 1956-1978 was 8.29 meters per year (m/yr) (van Beek and Meyer-Arendt, 1982). More recent analyses reveal that Louisiana shorelines are retreating at an average rate of 4.2 m/yr and range from a gain of 3.4 m/yr to a loss of 26.3 m/yr (U.S. Geological Survey (USGS), 1988). In comparison, the average shoreline retreat rates for the Gulf of Mexico, Atlantic seaboard, and Pacific seaboard were reported at 1.8, 0.8, and 0.0 m/yr, respectively. The highest reported rates of Louisiana's coastal retreat have occurred along the coastal plain of the Mississippi River. The sand beach formed between the Gulf and Bay Marchand retreated landward at rates of 18-23 m/yr between 1887 and 1978 (Penland and Suter, 1988). The average retreat rates for Fourchon Beach between the 1880's and 1980's have ranged from 10 to 20 m/yr (Boyd and Penland, 1988). The Isles Dernieres retreated landward at an average rate of 16.8 m/yr during the period of 1890 and 1988 (Williams et al., 1992). Whiskey Island, part of Isles Dernieres, retreated at an average rate of 26.3 m/yr during the same periods.

The coast of Chenier Plain is composed of sand beaches and coastal mudflats. The extensive mudflats seen in this area are the result of fine particle deposition from both the Mississippi and the Atchafalaya Rivers, where mud and fine particles are carried westward by the prevailing current. In some cases, this fluid-saturated mud extends several hundred meters seaward from the edge of the salt marsh communities found along the shore, absorbing wave energy and helping to protect these coastal wetland communities. Beaches in the Chenier Plain area are thin sand deposits present along the seaward edge of the marsh. The coastline of the Chenier Plain is relatively stable at this time.

The coast inshore of the Western Gulf of Mexico Planning Area extends from the Texas-Louisiana border to Bolivar Peninsula, just north of Galveston Bay. The Texas coastline represents a continuation of the Chenier Plain; however, the beaches and shoreline sediments present in this region are in a state of transgression. Thin accumulations of sand, shell, and caliche nodules form beaches that are migrating landward over tidal marshes. These beaches have poorly developed dunes and numerous washover channels.

From Galveston Bay southward to the Mexican border, the coast of Texas consists mainly of barrier islands. Barrier islands and sand spits present in this region along the Texas coast were formed from sediments supplied by three major deltaic headlands, including Trinity River delta (in the Galveston Bay area), the Brazos-Colorado-San Bernard Rivers delta complex (in Matagorda County, Texas), and the Rio Grand delta complex (in Cameron County, Texas).

Barrier islands in this region are arranged symmetrically around old, eroding delta headlands. Such islands tend to be narrow and sparsely vegetated, exhibiting a low profile with numerous washover channels.

3.1.2.6.2. Wetlands

Wetland habitats along the coast of the Gulf of Mexico consist of seagrass beds; mangroves; fresh, brackish, and salt marshes; mudflats; forested wetlands of hardwoods; and cypress-tupelo swamps. Wetland habitats may occupy only narrow bands along the shore, or they may cover vast expanses of the coastline. Seagrass beds, if present, are seen offshore in shallow water, while mangroves and marshes interface between marine and terrestrial habitats, and forested wetlands are found inshore, away from direct contact with the water.

High organic productivity, including detritus, and extensive nutrient recycling characterize coastal wetlands. The wetlands environment provides habitat for a vast number of invertebrate, fish, reptile, bird, and mammal species. Two-thirds of the high-value fishes caught in the Gulf of Mexico spend at least some portion of their life cycle in the nearshore seagrass beds or salt marshes (USDOI, MMS, 1990a).

Along the southwest Florida coast, there is a large stretch of coastal wetlands including those in the Florida Everglades and Everglades National Park, stretching from Cape Sable northward to Cape Romano (Figure 3-9). This area composes the Shark River drainage basin and is primarily a mangrove swamp community where it fronts on the open Gulf. North of Anclote Key throughout the Florida Big Bend area, another type of coastal wetland community fronts on the Gulf. This community consists of mud flats, oyster bars, and salt marsh habitats, which grade into coastal hammocks and maritime hardwoods farther from the shoreline.

Along the coast inshore of the Central Gulf of Mexico Planning Area, most mainland marshes behind Mississippi Sound occur as discontinuous wetlands associated with estuarine environments. In Alabama, most of the wetlands are located in Mobile Bay and along the northern side of Mississippi Sound. The more extensive coastal wetland areas in Mississippi are seen in the eastern part of the State, near the mouth of the Pearl River and in Pascagoula Bay. The marshes in Mississippi are more stable than those of either Alabama (to the east) or Louisiana (to the west), reflecting a more stable substrate and continued active sedimentation in the marsh areas. Major causes of marsh loss in Alabama have included industrial development, navigational dredging, natural succession, and erosion-subsidence (Roach et al., 1987).

Most of the coastal wetlands present in the Gulf of Mexico are found in Louisiana, where they occur in two physiographic provinces: the Mississippi River Deltaic Plain and the Chenier Plain (Figure 3-9). Existing wetlands in the Mississippi Deltaic Plain have formed over the last 6,000 years atop a series of overlapping riverine deltas. These wetlands developed in shallow areas that received flow and sediments from the Mississippi River. The effects of sea-level rise and high, natural subsidence of these organically rich sediments are continually impacting these wetlands (van Beek and Meyer-Arendt, 1982). Louisiana has the most rapidly retreating shoreline in the nation, with some estimates reaching as high as an average of 4 m per year (USGS, 1988). The most rapid rate of shoreline retreat is seen along the Mississippi River Deltaic Plain (Williams et al., 1992).

Chenier Plain, located to the west of Atchafalaya Bay, is a series of sand and shell ridges formed as sand dunes during the last ice age. These ridges are now separated by progradational mud flats, marshes, and open water. Localized sedimentation conditions have favored deposition in the Chenier Plain area.

In the 1980's, Louisiana, Alabama, and Mississippi contained 3,554,885 ha, 1,072,860 ha, and 1,767 ha of wetlands, respectively. During the following 10 years, Louisiana lost 199,074 ha, while Alabama and Mississippi lost 16,583 ha and 81 ha of wetlands, respectively (Hefner et al., 1994). Deterioration of wetlands, particularly along the Louisiana coastline, is an issue of concern (USDOI, MMS, 1997a). Several factors have contributed to the loss of wetlands in coastal Louisiana. Levee construction and efforts to conserve topsoil have reduced the Mississippi River's sediment load by 50 percent since the 1950's. Construction of ring levees has allowed drainage and development of vast wetland acreage. Development activities in low areas outside levees have caused wetlands to be filled in. Canals built for navigation and shoreline access have raised spoil banks where wetlands once existed. Canals have allowed greater impacts of tidal flushing in the freshwater and brackish water marshes, resulting in wetland loss, shifts in species composition, and habitat deterioration (Turner and Cahoon, 1988; Britsch and Kemp, 1990).

The portion of the Texas coast from the Louisiana border to the Bolivar Peninsula (just north of Galveston Bay) is physiographically part of the Chenier Plain. Estuarine marshes along the rest of the Texas coast occur in discontinuous bands around the bays and lagoons, on the inner sides of the barrier islands, and in the tidal reaches of rivers. Salt marshes, composed primarily of smooth cordgrass, are evident nearest to the mouths of bays and lagoons, in areas of higher salinities. Brackish water marshes are seen farther inland, and freshwater marshes occur along the major rivers and tributaries (White et al., 1986).

3.1.2.7. Seafloor Habitats

The major benthic habitat of the northern Gulf of Mexico consists of a soft muddy bottom, dominated by polychaetes. Other important seafloor habitats on the continental shelf of the northern Gulf that are more at risk to potential impacts from oil and gas operations include topographic features, live bottom areas, the pinnacle trend, and submerged seagrass beds. Important features on the continental slope include chemosynthetic (seep) communities. These and other benthic communities of the shelf and slope are also discussed below.

3.1.2.7.1. Topographic Features

Topographic features (or banks) with associated hard-bottom communities occur on the continental shelf and shelf edge in the western and central Gulf of Mexico (Figure 3-10). The major topographic features of the central and western Gulf of Mexico are listed in Table 3-5. These features are elevated above the surrounding seafloor and are characterized as either midshelf bedrock banks or outer shelf bedrock banks with carbonate caps (Rezak et al., 1983). Although these topographic features are small, the hard bottom faunal assemblages associated with them often have high diversity, species richness, and biomass; they also provide habitat for important commercial and recreational fish species.

The East and West Flower Garden Banks are two of the most prominent topographic features in the Gulf of Mexico, covering approximately 50 km^2 and 74 km^2, respectively. These features rise from surrounding water depths of greater than 100 m to a depth of 20 m at the crests. The banks formed over salt domes or diapirs, which forced the overlying bedrock upward, providing substrate for the colonization and growth of reef organisms. The crests of these features are carbonate rock formed by reef-building corals, coralline algae, and other lime-secreting creatures. The dominant community on these banks at water depths less than 36 m is composed of hermatypic corals including approximately 20 species, with an average percent cover of more than 50 percent (Bright et al., 1984; Dokken et al., 1999). Additionally, more than 80 species of algae, approximately 250 species of macroinvertebrates, and more than 120 species of fishes are associated with these features (NOAA, 1991; Bright et al., 1984; Dokken et al., 1999).

Seven biotic zones have been described for the topographic features by Rezak et al. (1983) and are detailed in Table 3-6. The zones have been classified into four major categories based upon amount of reef-building activity and primary production (Rezak et al., 1983; Rezak, 1985). The *Diploria-Montastrea-Porites* Zone, the *Madracis* and Leafy Algae Zone, the *Stephanocoenia-Millepora* Zone, and the Algal-Sponge Zone all fall within the zone of major reef-building activity and primary production. The *Millepora*-Sponge Zone falls within the zone of minor reef-building activity; the Antipatharian Zone falls in the transitional zone with minor to negligible reef-building activity; and the Nepheloid Zone falls in the zone of no reef-building activity.

3.1.2.7.2. Live Bottom Areas

Live bottoms are high productivity communities generally characterized by a high diversity of epibiota on rock or firm substrate. The sessile epibiota typically found in live bottom areas may include macroalgae, seagrasses, sponges, hydroids, octocorals, antipatharians, hard corals, bryozoans, and ascidians. In the Gulf of Mexico, these communities are found across the length of the west Florida shelf and in more restricted locations off Alabama, Mississippi, and Louisiana. Parker et al. (1983) estimated the amount of reef habitat or hard bottom on the Gulf of Mexico continental shelf at water depths between 18 and 91 m by lowering a camera system to the bottom at randomly selected locations. Between Key West and Pensacola, Florida, it was estimated that 38 percent of the seafloor consisted of hard-bottom/reef habitat. From Pensacola west to Pass Cavallo, Texas, only about 3 percent of the seafloor consisted of reef habitat.

The live bottom communities on the west Florida shelf are tropical to temperate in nature, with the number of tropical species decreasing to the north. The live bottom communities are predominantly algal/sponge/coral assemblages, with the shallow-water octocorals and the hard corals significantly decreasing in abundance at depths greater than about 40 m. Most of the hard bottom on the west Florida shelf is low relief (< 1 m), with a thin sand veneer often covering underlying rock (Woodward-Clyde Consultants and Continental Shelf Associates, Inc., 1983, 1985; Continental Shelf Associates, Inc., 1987). Despite the relatively small amount of actual exposed rock outcrops across this shelf, dense sessile epifaunal assemblages are common.

The Florida Middle Ground (Figure 3-10), an area of high-relief, hard-bottom features located approximately 160 km northwest of Tampa Bay, Florida, has generally been accepted as the northerly limit of significant coral communities in the eastern Gulf of Mexico (Grimm and Hopkins, 1977). These reef features rise from the seafloor at a 40-m water depth and crest at 23 m. The coral assemblage is relatively low in diversity due to its location at the northern range of hermatypic corals.

Live bottom communities on the shelf in the northeastern Gulf of Mexico are typically composed of small areas of low relief rock in primarily sand bottom areas. The hard bottom, found in water depths of 20 to 36 m, ranges from low relief exposed rock in shallow depressions to rock outcrops with a few meters of vertical relief. The dominant biota include coralline algae, hydroids, sponges, octocorals, solitary hard corals, bryozoans, and ascidians (Schroeder et al., 1989; Continental Shelf Associates, Inc., 1992a, 1994; Thompson et al., 1999).

Shipp and Hopkins (1978) conducted submersible surveys along the northwestern rim of the De Soto Canyon and reported a block-like limestone substrate with a relief of up to 10 m at 50- to 60-m water depths. Subsequent mapping and monitoring surveys have been conducted in this area by Continental

Shelf Associates, Inc. (1989, 1992a, 1994) and Barry A. Vittor & Associates, Inc. (1996). The variable-relief, hard-bottom substrates of this feature are primarily colonized by sponges, octocorals, antipatharians, bryozoans, and calcareous algae.

3.1.2.7.3. Pinnacle Trend

Ludwick and Walton (1957) described a region of discontinuous carbonate reef structures along the shelf edge between the Mississippi River Delta and De Soto Canyon (Figure 3-10). Subsequent MMS-sponsored studies (Brooks, 1991; Continental Shelf Associates, Inc., 1992b; Continental Shelf Associates, Inc., and Texas A&M University, Geochemical and Environmental Research Group, 1999) have provided further information about these features. Thousands of carbonate mounds ranging in size from less than a few meters in diameter to nearly a kilometer have been mapped and fall primarily in two parallel bands along isobaths. The larger "pinnacle" features are found between depths of 74 to 82 m and 105 to 120 m and have vertical relief ranging from 2 to 20 m. Linear ridges paralleling the isobaths were also mapped in the shallower depth zone. These appear to be biogenic features formed during periods of lower sea levels during the last deglaciation (Sager et al., 1992).

The pinnacle features provide a significant amount of hard substrate for colonization by suspension-feeding invertebrates, and support relatively rich live bottom and fish communities. At the tops of the shallowest features in water depths of less than approximately 70 m, assemblages of coralline algae, sponges, octocorals, crinoids, bryozoans, and fishes are present. On the deeper features, as well as along the sides of these shallower pinnacles, ahermatypic corals may be locally abundant, along with octocorals, crinoids, and basket stars. The diversity and abundance of the associated species appear to be related to the size and complexity of the features, with the low-relief rock outcrops (< 1 m height) typically having low faunal densities, and higher relief features having the more diverse faunal communities.

3.1.2.7.4. Submerged Seagrass Beds

Seagrass beds are extremely productive marine habitats that support a tremendously complex ecosystem. They provide nursery grounds for vast numbers of commercially and recreationally important fisheries species, including shrimps, black drum, snappers, groupers, spotted sea trout, southern flounder, and many others.

Seagrasses generally grow on sand bottoms in shallow, relatively clear water in areas with low wave energy. There are over 3 million ha of seagrass in the Gulf of Mexico. Approximately 98.5 percent of the seagrass beds in the Gulf of Mexico are located in the eastern Gulf, off the coast of Florida (USDOI, MMS, 1996a). In addition to this submerged aquatic vegetation, the Big Bend, northern Everglades, and Florida Bay all have extensive coastal wetland communities that front directly on the open waters of the Gulf (Continental Shelf Associates, Inc, and Martel Laboratories, Inc., 1986; Continental Shelf Associates, Inc., 1990, 1991).

Inshore of the Central and Western Gulf of Mexico Planning Areas, the coastal waters of Mississippi and Alabama contain approximately 30,000 ha of seagrass growing along the inner edges of the barrier islands of Mississippi Sound and along the shorelines of prominent bays. To the west, Texas nearshore waters contain approximately 15,000 ha of seagrass beds, most of which are located in the Laguna Madre and the Copano-Aransas Bay complex (Shew et al., 1981; USDOI, MMS, 1998).

Seagrass distributions inshore of the Eastern, Central, and Western Gulf of Mexico Planning Areas have declined over the last several decades due to a number of natural and manmade factors, including recent hurricanes, flooding, dredging, trawling, dredge material disposal, water quality degradation, and levee construction, which has diverted freshwater away from wetlands.

3.1.2.7.5. Chemosynthetic (Seep) Communities

Chemosynthetic communities, including vestimentiferan tube worms, seep mussels, vesicomyid and lucinid clams, and specialized polychaete worms, are associated with hydrocarbon seeps in the northern Gulf of Mexico at water depths ranging from less than 300 m to greater than 2,000 m. The chemosynthesis process is used by various bacterial groups that are able to oxidize hydrogen sulfide or methane to produce basic organic compounds. In deepwater areas where oil and natural gas compounds seep up through the sediments from deep reservoirs, these compounds are broken down near the sediment-water interface by microbes that remove the available oxygen and reduce seawater sulfate to hydrogen sulfide. In the case of mussels, methane is used as the energy source. The hydrogen sulfide can then be used by organisms possessing chemosynthetic bacteria. The chemosynthetic bacteria form symbiotic relationships with the host organisms, with the bacteria inhabiting specialized cells in the host. The host organism provides oxygen and chemosynthetic compounds such as hydrogen sulfide or methane to the bacteria, and the bacteria provide organic compounds to the host.

One of the best known seep communities, termed Bush Hill, consists of a dense community of vestimentiferan tube worms and mytilid mussels at a petroleum and gas seep (MacDonald et al., 1989). The community is located on a 300-m by 500-m mound extending 40 m above the surrounding bottom in Green Canyon Area Block 185 at a depth of 570 m. Shallow gas hydrates have been identified in corings of the mound (Brooks et al., 1986) and have been directly observed extruding from the sediments at the crest of the mound (MacDonald et al., 1994).

Vestimentiferan tube worms and mussels were also found in association with a brine seep at the base of the Florida Escarpment at a water depth of about 3,200 m (Paull et al., 1984; Hecker, 1985). The brine, which is seeping out of the sediments at the base of the escarpment, was found to be enriched in sulfides and possibly methane (Paull et al., 1985; Cavanaugh et al., 1987). Evidence indicates the vestimentiferan worms can be extremely slow-growing, less than 1 cm per year, and long-lived, with age estimates of greater than 200 years (Fisher et al., 1997; MacDonald, 2000). The seep mussels also exhibit slow growth rates with adults surviving up to 40 years (Nix et al., 1995; MacDonald, 2000).

Chemosynthetic communities have been found to be distributed through much of the northern Gulf of Mexico (MacDonald, 1992). Figure 3-11 shows known chemosynthetic community locations as reported by MacDonald (2000). Sassen et al. (1993) showed that where data were available, most significant oil fields in the deepwater Gulf had associated chemosynthetic communities. Since there is thought to be extensive natural oil and gas seepage in the Gulf of Mexico, the habitat is certainly available for these types of communities to be widespread, although small in individual areal extent. In addition, chemosynthetic communities not associated with oil and gas seepage have been found at the base of the Florida Escarpment at a water depth of about 3,200 m (Paull et al., 1984; Hecker, 1985). This site is a continental margin brine seep (or cold seep), where brines enriched in sulfides are formed by dissolution of the Florida Platform limestone.

3.1.2.7.6. Other Benthic Habitats

Continental Shelf

The continental shelf in the Gulf of Mexico extends from the coastline out to the shelf break at water depths ranging from about 118 to 150 m. Continental shelf soft-bottom communities in the Gulf of Mexico have been described in numerous studies and programs, including Lyons and Collard (1974); Defenbaugh (1976); Pequegnat et al. (1976); Dames and Moore (1979); Flint and Rabalais (1980); Bedinger (1981); Woodward-Clyde Consultants and Continental Shelf Associates, Inc. (1983, 1985); Continental Shelf Associates, Inc. (1987); and Brooks (1991). Based on size classifications developed by Rowe and Haedrich (1979) and Pequegnat (1983), shelf organisms and their associated communities are generally grouped as follows: (1) microfauna, less than 63 micrometers (µm) in size and consisting of bacteria and protists; (2) meiofauna, those animals living within the sediments with a size ranging from 63 to 500 µm; (3) macrofauna (or infauna), ranging in size from 500 µm up to an easily visible size; and (4) megafauna, those animals large enough to be easily visible.

Continental shelf soft-bottom communities are made up of various assemblages of animals comprising a large number of species. The assemblage or community species composition and abundance are determined by a variety of environmental conditions as well as population parameters. In addition to many biological influences, factors critical to the composition and distribution of the fauna in these communities may include substrate, temperature, salinity, water depth, currents, oxygen, nutrient availability, and turbidity.

Infaunal communities on the Gulf of Mexico continental shelf are generally dominated in both number of species and individuals by polychaete worms, followed by crustaceans and mollusks (Dames and Moore, 1979; Woodward–Clyde Consultants and Continental Shelf Associates, Inc., 1983, 1985; Continental Shelf Associates, Inc., 1987, 1992a, 1996; Brooks, 1991). These animals are typically distributed based upon water depth and sediment composition or grain size, with seasonal components also present in shallower water areas.

Based upon trawl specimens collected along the Gulf of Mexico continental shelf from Mexico to just east of the De Soto Canyon, Defenbaugh (1976) divided the shelf megafaunal or epibiotal assemblages into eastern and western assemblages with inner, middle, and outer shelf components. The major factor influencing the megafaunal distributions appeared to be the differing substrates, with primarily carbonate sediments found east of De Soto Canyon and along the west Florida shelf, and more terrigenous muds found to the west. Studies on the southwest Florida shelf in the early 1980's found soft-bottom megafaunal community zonation related to water depth or its correlates, including light, temperature, nutrient concentrations, or intensity of sedimentation and scour (Phillips et al., 1990).

Continental Slope and Deep Sea

Due to the water depths, remoteness, and difficulty in sampling these regions, the continental slope and deep-sea areas of the Gulf of Mexico have not been as well-studied as the continental shelf. The continental slope is a broad transition zone between the shelf and the central deep abyssal region of the Gulf of Mexico. The slope begins at the shelf break in depths ranging from approximately 118 to 150 m, and continues down to the continental rise at a depth of about 2,700 m. The continental rise then grades down to the abyssal plain, which ranges in depth from about 3,400 to 3,850 m. As with the shelf communities, water depth and sediment composition may be the most important environmental factors influencing the benthic communities of the deep Gulf. Salinity and temperature, which may vary significantly across the shelf, are generally very stable at depths below that of the upper continental slope and, thus, would be expected to have minimal impacts on the faunal distributions.

From 1964 through 1973, samples were collected from 264 deep-sea stations throughout the Gulf of Mexico at depths of up to more than 3,800 m, as reported by Pequegnat (1983). These samples, which were collected with various types of cores, grabs, dredges, trawls, and cameras, were identified to provide a large database for describing the slope and deep-sea benthic communities of the Gulf of Mexico from the De Soto Canyon west. From 1983 to 1985, benthic surveys were completed along transects on the northern Gulf of Mexico continental slope by LGL Ecological Research Associates and Texas A&M University (Gallaway, 1988). Stations were sampled on transects off Texas, Louisiana, and Florida at depths ranging from 300 to 2,900 m using box corers, trawls, and still cameras. Pequegnat et al. (1990) summarized deepwater studies relative to the northern Gulf of Mexico continental slope. Sampling efforts in the deepwater portions of the Gulf continue today. For example, the MMS-funded Northern Gulf of Mexico Continental Slope Habitats and Benthic Ecology Study involves the sampling of the water column and sediments at stations positioned along transects extending from the edge of the shelf to depths of over 3,000 m.

The deepwater megafauna of the Gulf of Mexico have been grouped into five or six faunal assemblages based upon the studies cited in the previous paragraph. Fishes, crustaceans, and echinoderms were the most common megafaunal groups collected during these studies and were the basis for the delineation of the five zones, defined in Table 3-7. Within the Shelf/Slope Transition Zone, large numbers of fishes, brachyurans, and asteroids are present. The Upper Archibenthal Zone has fewer fish species, more species of asteroids, and larger numbers of galatheid crabs, while the Lower Archibenthal Zone shows a further decrease in fish species, as well as in asteroids and echinoids. The Upper Abyssal Zone is characterized by a large increase in the number of large sea cucumbers and galatheid crabs, along with a further decrease in the number of species of brachyuran crabs. In the Mesoabyssal Zone, fishes are relatively rare, and in the Lower Abyssal Zone, the sea star *Dytaster insignis* is the most common species.

Gallaway (1988) noted a general decrease in meiofaunal and macrofaunal abundance with increasing depth from the continental slope to the abyssal areas in the Gulf of Mexico. There was a threefold decrease in meiofauna and a twofold decrease in macrofauna densities observed between 300 m and approximately 3,000 m.

3.1.2.8. Areas of Special Concern

3.1.2.8.1. Essential Fish Habitat

Section 303(a)(7) of the Magnusen-Stevens Fishery Conservation and Management Act (FCMA), as amended October 11, 1996 (16 U.S.C. 1801-1883), established that any fishery management plan (FMP) prepared by any Council or the Secretary of Commerce with respect to any fishery shall: (1) describe and identify essential fish habitat (EFH) for the fishery based on the guidelines established under section 305(b)(1)(A); (2) minimize to the extent practicable adverse effects on such habitat caused by fishing; and (3) identify other actions to encourage the conservation and enhancement of such habitat (Appendix E). The Interim Final Rule (50 Code of Federal Regulations [CFR] Part 600) defines EFH as the water and substrate necessary for fish spawning, breeding, feeding, and growth to maturity (Appendix 3-E). The Act also requires Federal Agencies to consult on activities that may adversely affect EFH's designated in the FMP's. The activities may have direct or indirect effects on EFH and be site-specific or habitat-wide. The adverse effects must be evaluated individually and cumulatively.

The fish species selected for EFH designation account for approximately one-third of the species managed by the GMFMC. They were selected because they are considered ecologically representative of the remaining species within their Fisheries Management Units. There was also sufficient information available to document their habitat associations and use. Collectively, all of these species occur throughout the estuarine and marine waters of the Gulf of Mexico.

The GMFMC Generic Amendment for addressing EFH in the Gulf of Mexico and the FMP for Atlantic tunas, swordfish and sharks were consulted to gather information on EFH for the Federal waters of the Gulf of Mexico. Tables 3-8, 3-9, and 3-10 list those species and life stages whose EFH occur within the Federal waters of interest. For each species, the tables also indicate whether the habitat for the appropriate life stage is pelagic (oceanic or coastal) or benthic (soft bottom or hard bottom). In some cases, such as with corals and several shark and reeffish species, there was insufficient information available to accurately describe EFH.

Table 3-8 presents invertebrate and reeffish species managed by the GMFMC for which EFH has been identified. Corals were not included in the table since there are many soft and hard coral species in the Gulf, and formal EFH descriptions have yet to be made by the GMFMC. Table 3-9 presents EFH information for managed coastal pelagic species and red drum. Table 3-10 gives EFH for highly migratory species such as swordfish, tunas, and sharks managed by the NMFS. Although billfish (sailfish, *Istiophorus platypterus*), blue marlin (*Makaira nigricans*), white marlin (*Tetrapterus albidus*), and longbill spearfish (*T. pfluegeri*) are now considered highly migratory species, there were no EFH designations in NMFS (1999).

An amendment to the FMP for coral and coral reefs of the Gulf of Mexico included coral reef communities or solitary specimens existing throughout the Gulf of Mexico. In the Gulf of Mexico, corals are concentrated primarily in the East and West Flower Garden Banks, the Florida Middle Ground, and the extreme southwestern tip of the Florida Reef Tract. Coral are suspension feeders, and their prey is predominantly planktonic organisms carried in the water column.

Habitat Areas of Particular Concern

Within the EFH Interim Final Rule, the NMFS recommended that FMP's identify habitat areas of particular concern (HAPC's) in EFH. In response to this recommendation three general types of HAPC have been identified for all FMP-managed species (GMFMC, 1998): (1) nearshore areas of intertidal and estuarine habitats with emergent and submerged vegetation, sand and mud flats, shell and oyster reefs, and other substrates that may provide food and rearing for juvenile fish and shellfish; migration routes for adult and juvenile fish and shellfish; and areas sensitive to human-induced developmental activities; (2) offshore areas with substrates of high habitat value and diversity or vertical relief that serve as cover for fish and shellfish; and (3) marine and estuarine habitat used for migration, spawning, and rearing of fish and shellfish, especially in areas adjacent to intensive human-induced developmental activities.

The GMFMC has designated nine HAPC's to date. Although most are not located within the leasing program areas, all of these HAPC's are important with respect to corals and coral reefs, and provide habitats for reef species such as snappers, groupers, and spiny lobster. The Flower Garden Banks National Marine Sanctuary is an HAPC. It is located 161 km off the coasts of Texas and Louisiana, and is located within the Western Gulf of Mexico Planning Area in the vicinity of proposed or past OCS lease sales (Figure 3-11). The Weeks Bay National Estuarine Research Reserve is located off U.S. Highway 98 between Mobile, Alabama, and Pensacola, Florida. Grand Bay, Mississippi, is located in southeast Jackson County. It includes approximately 6,070 ha of estuarine tidal marsh, shallow-water open bay, wet pine savannah, and coastal swamp habitats. Approximately 3,900 ha are State-owned estuarine marsh and shallow-bay bottoms that are currently recognized as the Grand Bay Estuarine Reserve.

3.1.2.8.2. National Marine Sanctuaries, Parks, Refuges, and Reserves

Marine Sanctuaries

Two national marine sanctuaries have been established in the Gulf of Mexico–the Florida Keys National Marine Sanctuary in south Florida and the Flower Garden Banks National Marine Sanctuary located off the coast of Texas/Louisiana (Figure 3-12). The Florida Keys National Marine Sanctuary, designated in November 1990, was established to allow management and protection of the marine ecosystems around the Florida Keys. The boundaries of the Sanctuary include various types of coral reef areas, seagrass beds, mangrove shorelines, and sand flats. The reefs and surrounding environments contain high-diversity biological communities that are easily impacted by the activities of man. To better allow the protection and management of the Sanctuary, special restriction zones were established to protect the sensitive habitat within these areas. These zones include wildlife management areas, ecological reserves, sanctuary preservation areas, existing management areas, and special-use areas.

The Flower Garden Banks National Marine Sanctuary, designated in 1992, is located about 200 km southeast of Galveston, Texas, and represents the northernmost coral reef system in the United States. The area containing both the East and West Banks covers 124 km^2 in size and contains 142 ha of reef crest. In October 1996, Congress expanded the sanctuary by adding a small third bank. Stetson Bank, also a salt dome, measures about 800 m long and 300 m wide and is located about 70 nautical miles south of Galveston, Texas. Environmental conditions at Stetson Bank do not support the growth of reef forming corals like those found at the East and West Flower Garden Banks. Stetson Bank is capped by uplifted layers of claystone and sandstone which have eroded at unequal rates to create a strange "moonscape" appearance and is home to many species of invertebrates and fish. The shallower reef areas of the Flower Garden Banks National Marine Sanctuary are dominated by the hermatypic corals *Montastrea annularis*, *Diploria strigosa*, *Porites astreoides*, and *Montastrea cavernosa*, along with associated fishes and invertebrates. The USDOI, MMS has protected the biological resources of the Flower Garden Banks from potential damage due to oil and gas exploration by establishing a “No Activity Zone” and by other operational restrictions in the vicinity of the banks. By designating the area as a national marine sanctuary, other protective measures have been provided by regulating the following activities:

- injuring, removing, possessing, or attempting to injure or remove living or nonliving sanctuary resources;
- feeding fishes and certain methods of taking fishes;
- vessel anchoring and mooring;
- discharging or depositing polluting materials within the sanctuary;
- discharging or depositing polluting materials outside the sanctuary boundaries that subsequently enter the sanctuary and injure a sanctuary resource or quality; and
- altering the seabed or constructing, placing, or abandoning any structure or material on the seabed.

A long-term ecological monitoring program has been ongoing at the Flower Garden Banks since 1989. The most recent report indicates that, by all growth measures applied, the East and West Flower Garden Banks coral communities appear to be healthy and growing (Dokken et al., 1999).

National Park System

The National Park System assures protection and interpretation of some of the finest examples of this country's natural, cultural, and recreational resources. Examples found along the coast or coastal areas of the Gulf of Mexico include Padre Island Seashore, Jean Lafitte National Historic Park, Gulf Islands National Seashore, DeSoto National Memorial, Big Cypress National Preserve, Everglades National Park, and Dry Tortugas National Park. More than 177 km of coastal beaches and barrier islands in Texas, Mississippi, and Florida serve millions of visitors each year at Padre Island and Gulf Islands National Seashores (Figure 3-12). The more than 890,340 ha within south Florida's Everglades National Park and Big Cypress National Preserve contain extensive areas of marshes, wetlands, and estuaries providing habitat for unique temperate and tropical flora and fauna. The Dry Tortugas National Park contains Fort Jefferson, originally built to guard the major sea lane between the Caribbean and the Gulf of Mexico. The park also contains some of the most pristine coral reefs in the Florida reef tract.

National Wildlife Refuges

The National Wildlife Refuge System is a network of U.S. lands and waters managed specifically for the enhancement of wildlife. There are 30 national wildlife refuges located along the coastline or within the coastal areas of the Gulf of Mexico from Texas through Florida (Table 3-11). Most refuges along the Gulf coastline were established to provide wintering areas for ducks, geese, coots, and other migratory waterfowl and shorebirds. Threatened and endangered species including the bald eagle, brown pelican, alligator, and manatee also use the refuges in the Gulf.

Established in 1904, Breton National Wildlife Refuge (Figure 3-12) is the second oldest refuge in the National Wildlife Refuge System. Breton National Wildlife Refuge is managed primarily as a sanctuary for nesting and wintering seabirds. Brown pelicans, peregrine falcons, and sea turtles are some of the endangered species known to frequent the refuge. About 2,025 ha of the refuge are designated as part of the National Wilderness Preservation System. Another approximately 800 ha are comprised of nonwilderness, State-owned islands and gas facilities on Federal land, all managed as part of the refuge. The refuge objectives of Breton National Wildlife Refuge are to: (1) protect and preserve the wilderness character of the islands and (2) provide sandy barrier beach habitat for a variety of wildlife species.

National Estuarine Research Reserves

The National Estuarine Research Reserve Program was established by the Coastal Zone Management Act of 1972 and is administered by the Sanctuaries and Reserves Division, National Ocean Service, NOAA. One of the primary objectives for establishing this program was to provide research information to be utilized by coastal managers and the fishing industry to help assure the continued productivity of estuarine ecosystems. Three estuarine research reserves have been established in the Gulf of Mexico area, as detailed below.

- Weeks Bay National Estuarine Research Reserve in coastal Alabama includes a small estuary covering approximately 1,225 ha. The reserve is composed of open shallow waters, with an average depth of less than 1.5 m and extensive vegetated wetland areas. Freshwater enters from the Fish and Magnolia Rivers, and the reserve connects with Mobile Bay through a narrow opening.
- The Rookery Bay National Estuarine Research Reserve, south of Naples, Florida, covers approximately 5,060 ha and includes mangroves, open bays, creeks, pine flats, hardwood

hammocks, oyster reefs, and seagrass beds. A marine laboratory is located within the reserve, with management of the reserve provided by the Florida Department of Environmental Protection, the Nature Conservancy, and the National Audubon Society.

- The Apalachicola National Estuarine Research Reserve, southeast of Panama City, Florida, covers approximately 78,500 ha that consists of forested flood plains, salt and freshwater marshes, barrier islands, and open bays. A Federal refuge and a State park are within the reserve boundaries. An oyster fishery is the prime business of the adjacent Apalachicola area.

National Estuary Program

In 1987, the National Estuary Program was established under provisions of the Water Quality Act. The purposes of the program are to identify nationally significant estuaries, to protect and improve their water quality, and to enhance their living resources. Under the administration of the USEPA, comprehensive administration plans are generated to protect and enhance environmental resources of estuaries designated to be of national importance. The governor of a State may nominate an estuary for the program and may request that a Comprehensive Conservation and Management Plan be developed. Over a 5-year period, representatives from Federal, State, and interstate agencies; academic and scientific institutions; and industry and citizens groups work to define objectives for protecting the estuary, select the chief problems to be addressed in the plan, and ratify a pollution control and resource management strategy to meet each objective.

The Gulf of Mexico estuaries currently falling within the National Estuary Program include the following: Corpus Christi Bay, Galveston Bay, Barataria-Terrebonne Estuarine Complex, Mobile Bay, Tampa Bay, Sarasota Bay, and Charlotte Harbor.

3.1.3. Socioeconomic Environment

3.1.3.1. Population, Employment, and Regional Income

Offshore waters of the Western, Central, and Eastern Gulf of Mexico Planning Areas lie adjacent to coastal Texas, Louisiana, Mississippi, Alabama, and Florida. In this description of the socioeconomic environment, sets of counties (and parishes in Louisiana) have been grouped on the basis of intercounty commuting patterns. The Labor Market Areas (LMA's) identified by this grouping are commuting zones, as identified by Tolbert and Sizer (1996). In their research, Tolbert and Sizer (1996) used journey-to-work data from the 1990 Census to construct matrices of commuting flows from county to county. A statistical procedure known as hierarchical cluster analysis was employed to identify counties that were strongly linked by commuting flows. The researchers identified 741 of these commuting zones for the United States. Twenty-three of these LMA's areas span the Gulf Coast, from the southern tip of Texas to Miami and the Florida Keys (Figure 3-13).

The LMA's adjacent to the Western Gulf of Mexico Planning Area are all within Texas and include Brownsville, Corpus Christi, Victoria, Brazoria, Houston-Galveston, and Beaumont-Port Arthur. The LMA's adjacent to the Central Gulf of Mexico Planning Area include Lake Charles, Lafayette, Baton Rouge, Houma, and New Orleans, Louisiana; Biloxi-Gulfport, Mississippi; and Mobile, Alabama. The LMA's adjacent to the Eastern Planning Area are all within Florida and include Pensacola, Panama City, Tallahassee, Lake City, Gainesville, Ocala, Tampa-St. Petersburg, Sarasota, Naples, and Miami. Use of the LMA geography brings together not only counties immediately adjacent to the Gulf of Mexico, but also counties tied to coastal counties as parts of functional economic areas. An analysis that encompasses where people live as well as where they work permits a more meaningful assessment of the impact of offshore oil and gas activities

3.1.3.1.1. The Structure of Regional Population and Employment

Table 3-12 provides an overview of the Gulf Coast LMA population arranged by State. The 1970, 1980, and 1990 population figures are taken from the corresponding decennial census for that year. The 1999 data are estimates developed by the USDOC, Bureau of the Census. Each of the planning areas has one or two large population anchors; nevertheless, all Gulf Coast LMA's encompass small to medium-sized urban agglomerations.

Table 3-13 displays components of population and employment in the Gulf of Mexico coastal region. This area's population increased 33 percent between 1970 and 1980. This was followed by a more modest increase of 18 percent between 1980 and 1990. Since the 1990 decennial census, the Bureau of the Census estimates that the region's population has grown 15 percent as of 1999, yielding a total of more than 20 million persons. In the United States, population age structures typically reflect the presence of the baby boom generation. This scenario is manifested in the Gulf Coast region by the relative decline in lower age cohorts over time. Population aging is disclosed in the over 65 category where the highest growth rate occurs. More distinctive is the changing race and ethnic composition of the region, which has a longstanding tradition of cultural heterogeneity (Gramling, 1994). While the African-American population has remained relatively constant over time, the Hispanic population has nearly doubled (11 percent in 1970 versus 20 percent in 1990), and the white population has declined by nearly 10 percent.

In terms of education, the region has exhibited a steady upgrading of skill levels. For example, the percentage of persons having attended or graduated from college doubled between 1970 and 1990. The region's civilian labor force expanded substantially from 1970 to 1980 and more modestly from 1980 to 1990. However, the military labor force has exhibited a steady decline over time, culminating in a 29-percent decrease. Based on employment, the largest industry sectors in the Gulf Coast region are services and wholesale/retail trade. The most notable change in the occupation distribution has been the increased share for technical, management, and professional occupations. These overall trends vary substantially from one Gulf Coast State to another and from one LMA to another.

In general, the States adjacent to the three Gulf of Mexico Planning Areas (Western, Central, and Eastern) exhibit a mix of similar and distinctive demographic and employment characteristics. However, the aggregated data mask even more local variations.

3.1.3.1.2. Population and Labor Force Projections

Figure 3-14 and Table 3-14 present population trends and projections for the Gulf Coast commuting zone from 1980 to 2020. The area is projected to realize increases in population, although this tapers off throughout the projection period. During these decades, the Gulf Coast is projected to experience a considerable shift in age structure. This is seen clearly in Table 3-14. Until 2010 (including the 2002-2007 period being considered in this analysis), when the baby boomers begin to retire, the fastest growing age group will continue to be the 35-64 year olds. After 2010, the proportion in this age group begins to decline. However, the younger age groups (i.e., 0-19, 20-34) will continue to grow slowly and maintain the same proportion throughout the post-2000 period. The net result is that population growth will moderate around 1 percent per year by the end of this period. Meanwhile, the age structure of the region will shift toward the more elderly.

Differences in age structure, as well as net migration, among the coastal commuting zone areas could create variations in population growth. The highest rates of growth are expected adjacent to the Western Gulf of Mexico Planning Area and lowest adjacent to the Central Gulf of Mexico Planning Area. Southern Florida and western Texas areas are projected to have the highest growth rates, exceeding those expected for Louisiana and Mississippi. The lowest population growth rates are expected in the coastal Louisiana commuting zones. Population growth rates are all projected to decline throughout the first two decades of the 21st century.

Figure 3-14 also presents labor force trends and projections from 2000 to 2020 for the Gulf of Mexico coastal commuting zones of interest. Although labor force changes and population changes are interrelated, trends can and do diverge when much of the change in population is found in the nonworking ages. This is the case in the coastal commuting zones, as reflected in Table 3-15. The divergence in labor force trends and population change is evident by comparing the two charts in Figure 3-14, where population changes are expected to remain generally constant while 5-year labor force rates decrease throughout the projection period. Once in double digits during the 1980-1985 period, labor force growth is projected to drop to 2.23 percent for the coastal areas by the 2015-2020 period. Labor force growth rates are also expected to drop considerably faster than population growth rates throughout the first two decades of the 21st century. This difference between population and labor force is due to population aging.

For the region, the proportion of the labor force in younger ages (i.e., 20-34) is projected to stabilize at a little over 30 percent, with a slight proportionate rise in 2015 and 2020. At the same time, the proportion of older workers (i.e., 35-64 years of age) stabilizes in the region then declines after 2010. These cohort effects characterize all commuting zones; however, some areas are more affected than others. Throughout the coastal areas, growth rates are projected to fall for the entire projection period. As with projected population, projected labor force growth is highest in the western Gulf (i.e., Texas) and lowest in the central Gulf (i.e., Louisiana, Mississippi, Alabama). Labor force growth in the eastern Gulf (i.e., Florida) is only slightly less than projected for the western Gulf. For all areas, cumulative growth for the first two decades of the 21st century is largely set between 2000 and 2005.

Although projections show labor force growth slowing considerably during the first two decades of the 21st century, these growth rates vary considerably by industry, as seen in Table 3-16a. For the coastal area noted, the overall change in labor force of nearly 20 percent is primarily driven by retail and services growth (20.1% and 38.0%, respectively). While farming is projected to continue its long-term employment decline (-11.3%), related activities in agricultural services, forestry, and fisheries are projected to realize an increase in employment (34.26%). Total employment in the oil and gas industry is projected to decrease from 143,490 to 116,000. This would constitute a loss of over 19 percent for the coastal commuting zones, irrespective of any proposed offshore activities. This loss is concentrated in absolute numbers in the western portion of the Gulf. While showing greater rates of decline, the coastal communities adjacent to the Central Gulf of Mexico Planning Area are projected to account for less of the total job decline in the oil and gas industry. The eastern portion of the Gulf will account for relatively few jobs in this industry, although, this Statewide or multi-state trend varies considerably (i.e., by specific area).

3.1.3.1.3. Regional Income

Table 3-16b shows trends in regional income. Projected changes in regional income are determined by expected shifts in wages within industries and by the employment growth patterns shown in Table 3-16a. For coastal areas, projected growth in wages (in 1987 constant dollars) increases by nearly 40 percent between 2000 and 2020. Services, which are projected to increase aggregate earnings by more than 60 percent during this 20-year time period, account for more of this increase than any other industry. In other industries, such as manufacturing, rapid growth in projected average wages compensate for moderate employment growth, making these industries strong contributors to overall regional income.

The oil and gas industry shows moderate losses in overall earnings. However, growth in average wages somewhat offsets the more rapid employment losses projected earlier. Louisiana, Mississippi, and Alabama are projected to have the greatest loss in aggregate earnings, dropping from $95 million in 2000 to $81 million in 2020. Declining by 14.63 percent, these States show both the largest proportional and total loss in earnings. Texas is also projected to drop, from $168 million to $156 million, a loss of 7.11 percent in overall earnings. Florida is projected to remain virtually unchanged during this time period, adding some $11 million annually to regional income.

3.1.3.2. Land Use and Existing Infrastructure

The 23 coastal LMA's (Figure 3-13) of the Gulf of Mexico Region constitute a rich, natural mix of bays, estuaries, wetlands, barrier islands, and beaches. Though accessibility is sometimes quite limited, these areas are very popular for recreation and tourism. Land use is a heterogeneous mix of settlements; recreation areas; tourist attractions; and manufacturing, marine, shipping, agricultural, and oil and gas activities. It is important to note that every LMA encompasses one or more metropolitan statistical areas (MSA's); urbanized areas are well established in each area, and a complexity of land use associated with urbanization can be found in each of these LMA's. The 23 LMA's are composed of 59 metropolitan counties (i.e., designated as MSA's). Since land-use patterns are complex in urban areas, it is more instructive to examine land use in the nonmetropolitan counties and parishes that are part of the Gulf Coast LMA's.

The U.S. Department of Agriculture's Economic Research Service (ERS) classifies nonmetropolitan counties into economic types that indicate primary land-use patterns (Cook and Mizer, 1994). Most notably, only 7 of the 71 nonmetropolitan counties are classified by ERS as farming dependent. An equal number are defined as mining dependent, suggesting the importance of oil and gas development to these local economies. Manufacturing dependence is noted for another 12 of the nonmetropolitan counties. Local school districts and public facilities, such as hospitals and prisons are often the largest employers in sparsely populated rural areas. Thus, it is not surprising that 18 of the 71 nonmetropolitan counties are classified by ERS as government employment centers. Another 14 of the nonmetropolitan counties have economies tied to service employment. The ERS also classifies counties in terms of their status as a retirement destination. Seventeen of the 71 nonmetropolitan counties are considered major retirement destinations by ERS. Of the these, 11 are inshore of the Eastern Gulf of Mexico Planning Area where little offshore development has taken place. The varied land-use patterns are detailed in Figure 3-15.

The Western and Central Gulf of Mexico Planning Areas, offshore Texas, Louisiana, Mississippi, and Alabama, are two of the most active offshore oil and gas areas in the world (Gramling, 1994). Only limited offshore activities (i.e., exploratory activities, single major project) have occurred in the Eastern Gulf of Mexico Planning Area, and there is very little infrastructure in place to support exploration and development of offshore oil and gas off the Gulf coast of Florida. Most of the equipment and facilities supporting offshore Gulf of Mexico oil and gas operations are located inshore of the Western and Central Gulf of Mexico Planning Areas. As Figure 3-16 indicates, key onshore infrastructure includes supply bases, shipyards, platform fabrication yards, pipe yards, oil refineries, gas processing facilities, and helicopter pads. Equipment utilization varies over time, depending on a variety of factors, including commodity prices. As of September 8, 2000, 178 of 206 mobile offshore drilling rigs were under contract. This 86-percent utilization contrasts with a 79-percent utilization figure 5 years ago.

Socioeconomic analysis of deepwater oil and gas development impacts is just underway. Early indications are that, due to the high cost of exploration and development and technological challenges, price considerations are not driving deepwater activity. The downturn in oil and gas prices of the late 1990's was not accompanied by a reduction in deepwater operations. In the high price environment of early 2001, there is little evidence of any change in the pace of deepwater activities. In terms of infrastructure, the advent of deepwater development is nonetheless important. Construction and servicing of remote deepwater facilities require deeper ports than nearshore operations. There are only a few ports with deepwater access along the Gulf Coast, and this concentrates deepwater development activities in these few places. The demand for such infrastructure is likely to increase in light of current and future leasing.

3.1.3.3. Fisheries

3.1.3.3.1. Commercial Fisheries

Commercial fisheries are very important to the economies of the Gulf Coastal States (Browder et al., 1991). The Gulf of Mexico leads all other U.S. regions in fishery production. In 1999, commercial fishery landings in the Gulf of Mexico, which includes western Florida, Alabama, Mississippi, Louisiana, and Texas, exceeded 882,000 metric tons (t), worth over $700 million (USDOC, NMFS, 2000). Of the individual States, Louisiana led in total landings and value in 1999 with 680,250 t landed, worth $294 million. Mississippi was second with landings exceeding 121,538 t, worth $49 million, followed by Texas (40,362 t, $218 million), Florida's west coast (40,362 t, $162 million), and Alabama (12,245 t, $50 million). These trends are illustrated in Figure 3-17.

Many species are caught and landed in Gulf of Mexico commercial fisheries. Browder et al. (1991) stated that the Gulf of Mexico commercial fishery includes at least 97 species from 33 families. They considered the most important species groups to be oceanic pelagic (epipelagic) fishes, reef (hard bottom) fishes, coastal pelagic species, and estuarine-dependent species. The primary estuarine dependent species targeted are menhaden, penaeid shrimps (brown, white, and pink), and blue crab. (Oysters are important, but not considered here because they are harvested exclusively in inshore waters.) Targeted species from the other groups include yellowfin tuna and swordfish (epipelagic); king and Spanish mackerels (coastal pelagic); and spiny lobster, red snapper, red grouper, and gag (reef/hard bottom).

Each species or species group is caught using various methods and gear types. Shrimps are taken by bottom trawling, menhaden are caught in purse nets, yellowfin tuna are caught on surface longlines, and snapper and grouper are caught by hook and line; pots and traps are used for crab, spiny lobster and some fish species. Table 3-17 summarizes main commercial fishing practices and seasons in the Gulf of Mexico.

Generally, Gulf of Mexico fishing activities with the highest potential for interactions (or conflicts) with OCS oil and gas operations are bottom trawling (potential for snagging on pipelines and debris) and surface longlining (potential for space-use conflicts with seismic survey vessels).

Landing values (in percent) of the Gulf Coast States are given for the top 15 species in Figure 3-18. Two penaeid shrimp species (i.e., brown and white) were the most valuable species landed in both 1998 and 1999. Other invertebrates such as blue crab, spiny lobster, stone crab, and rock shrimp contributed significantly to the landings value. Valuable finfish landed during 1998 and 1999 were menhaden, yellowfin tuna, red snapper, red grouper, gag, and striped mullet.

In terms of pounds landed in 1998, menhaden, a small coastal pelagic species, contributed the highest proportion (71.8%) of the landings. Shrimps and blue crab were also important, collectively representing about 16 percent of the total 1998 landings by weight. Other species composing the list included reef fishes (red snapper and red grouper), epipelagic fishes (yellowfin tuna), demersal soft bottom fishes (black drum), and coastal pelagic fishes (mullets and sharks).

3.1.3.3.2. Recreational Fisheries

The primary source for marine recreational fisheries data in U.S. waters is the USDOC, NMFS Marine Recreational Fisheries Statistics Survey (MRFSS). This survey combines random telephone interviews with on-site intercept surveys of anglers to estimate recreational catch and effort for inland, State, and Federal waters. In the Gulf of Mexico, surveys are conducted in western Florida, Alabama, Mississippi, and Louisiana. Texas conducts its own surveys; these data were not currently available. The MRFSS data for 1998 were obtained from USDOC, NMFS (2000b). Other recreational fishing information is available in USDOI, MMS (1999).

An estimated 4 million fishers from Florida, Alabama, Mississippi, and Louisiana engaged in some form of recreational fishing during 1998. These anglers fished from shore, piers, jetties, private/rental boats, party boats, and charter boats. Recreational fishing takes place from inland waters to the open Gulf, with most effort concentrated in coastal and inshore waters.

Of the four States, western Florida had the highest number of anglers and saltwater fishing trips in 1998, followed (in descending order by number of trips) by Louisiana, Alabama, and Mississippi. Figure 3-19 provides the estimated numbers of anglers and trips taken during 1998 by State (USDOC, NMFS (2000b).

The mode of fishing that was most common in all Gulf of Mexico States was private/rental boats, comprising over 50 percent of the effort in each State. This was followed closely by fishing from shore and distantly by fishing from charter/party vessels. Party boats operate mostly from ports in Florida and Alabama, whereas, charter boats were found in all Gulf Coast States (Continental Shelf Associates, Inc., 1997; USDOI, MMS, 1999).

In 1998, the percentage of effort expended in inland, State, and Federal waters varied by State. In Mississippi and Louisiana, most trips were made in inland waters as opposed to State and Federal waters. In Florida and Alabama, the percentage of trips made in State waters was much higher than the other two States.

Fishing in State and offshore shelf waters often occurs around artificial structures. Off Alabama, Mississippi, Louisiana, and Texas, these structures are oil and gas platforms (Stanley and Wilson, 1991; Continental Shelf Associates, Inc., 1997; USDOI, MMS, 1999). A recent MMS study estimated that during 1999 there were 2.2 million oil and gas structure visits associated with recreational fishing and diving, with a total of $172.9 million in direct expenditures associated with these visits (Hiett and Milon, 2000).

The top five species commonly caught by recreational fishers in the Gulf Coast States are illustrated in Figure 3-20 (USDOC, NMFS, 2000b). Spotted sea trout, an inshore species, was the most common fish caught by recreational anglers in the Gulf of Mexico during 1998. The estimated catch of spotted sea trout for 1998 was over 20 million fish. The target species varied among States, with

Florida being somewhat different than the other three States. This difference reflected the prevalence of hard-bottom species such as gray snapper, white grunt, and gag in the Florida catches. Recreational fishers in the other three States caught soft-bottom species such as red drum and sand sea trout (USDOC, NMFS, 2000b). The species in Figure 3-20 are primarily inshore forms. In offshore oceanic waters of the Gulf of Mexico, commonly sought species include yellowfin tuna, sailfish, blue marlin, dolphin, wahoo, and sharks (Continental Shelf Associates, Inc., 1997). Catch and effort for these epipelagic fishes is much less than for the inshore and shelf species (Continental Shelf Associates, Inc., 1997).

3.1.3.4. Tourism and Recreation

The northern Gulf of Mexico coastal zone is one of the major recreational regions of the United States, particularly in connection with marine fishing (see Figure 3-19) and beach-related activities. The shorefronts along the Gulf coasts of Florida, Alabama, Mississippi, Louisiana, and Texas offer a diversity of natural and developed landscapes and seascapes. The coastal beaches, barrier islands, estuarine bays and sounds, river deltas, and tidal marshes are extensively and intensively utilized for recreational activity by residents of the Gulf South and tourists from throughout the Nation, as well as from foreign countries. Publicly owned and administered areas (such as national seashores, parks, beaches, and wildlife lands), as well as specially designated preservation areas (such as historic and natural sites and landmarks, wilderness areas, wildlife sanctuaries, and scenic rivers), attract residents and visitors throughout the year. Commercial and private recreational facilities and establishments (such as resorts, marinas, amusement parks, and ornamental gardens) also serve as primary interest areas and support services for people who seek enjoyment from the recreational resources associated with the Gulf of Mexico.

Recreation and tourism are major sources of employment along the Gulf Coast. To estimate travel/tourism related industries, a review of Public Use Micro Data was conducted (Tolbert et al., 1995). Labor markets in the Gulf region were evaluated. Employment data from 1990 were derived from various travel-related industries, such as hotel, motels, and other lodging places; eating and drinking establishments; food stores; amusement/recreational services; car rentals; gasoline service stations; air passenger transportation; local passenger transportation; travel arrangements; and general merchandise stores.

The ratio of employment in these industries to the total labor force was then calculated and applied to the associated labor force projected for the 23 commuting zones. (Table 3-18).

It can generally be deduced that almost 40 million residents of the Gulf Coast States have a major interest in water-related and water-enhanced recreational activity, with approximately two-thirds of the Gulf shorefront composed of beach; also, there is one motorboat for about every 20 people living in the Gulf region. In an attempt to narrow the scope of this information to the coastal zone, approximately 14 million people, or 35 percent of the Gulf States' population, live in coastal counties/parishes or the area most directly affected by Gulf activity, and about one-third of the two million registered motor boats are likely candidates for use in association with marine recreational activity.

The greatest concentration of tourism related employment occurs in Florida, as reflected in Table 3-18. The Miami and Panama City commuting zone LMA's have the highest percentages of tourism employment with 20 percent. The Ft. Myers and Sarasota LMA's also have relatively high concentrations (18%) of tourism-related employment. In the Central Gulf of Mexico Planning Area, the New Orleans and Houma LMA's are also high (18%).

Areas with the lowest percentage of tourism employment in Texas include Victoria (10%) and Brazoria (12%). The LMA's in coastal Mississippi and Alabama have relatively low levels of tourism-related employment, based on 1990 data. The percentage of tourism related employment in the Mobile and Biloxi coastal zones are 12 percent and 14 percent, respectively. The advent of the gaming industry along the Mississippi coast may alter this trend following review of the Census 2000 data. Census data from 1990 indicate that recreation and tourism employment is a nontrivial component of local economies across the Gulf coast region (Tolbert et al., 1995).

Between 1984 and 1987, the USDOC, NOAA, Office of Strategic Assessment inventoried public recreation areas in coastal areas throughout the United States. Their final report and data atlas (USDOC, NOAA, 1988) indicate that 308 public agencies (289 local, 14 State, and 5 Federal) owned and/or managed outdoor recreation areas and facilities in coastal areas of the Gulf of Mexico Region. Public agencies managed 4,137 recreation sites greater than one acre in size in the Gulf's coastal zone. According to NOAA's report, 601 of these public recreation sites provide access to tidally influenced water, and 215 provide access to Gulf of Mexico open waters. The atlas provides extensive data on public recreation lands and waters, as well as the number of boat ramps, boating slips, docks, fishing piers, campsites, artificial reefs, and beach miles within every coastal county/parish associated with the Gulf of Mexico Region.

According to NOAA (Meade and Leeworthy, 1986) in Fiscal Year 1982, $525 million in public funds were spent for outdoor recreation in Gulf coastal counties, an average of $44 per resident. Total public recreation expenditures and expenditures per capita are less in the Gulf Coast region than any other coastal region of the United States (Pacific, South Atlantic, and North Atlantic).

3.1.3.5. Sociocultural Systems and Environmental Justice

Sociocultural systems in the Gulf of Mexico are complex and multifaceted. They are made up of numerous cultural groups, some that have changed, some that have maintained, and some that have become assimilated over time. Data presented in Sections 3.1.3.1 and 3.1.3.2 on the socioeconomic character of coastal areas along the Gulf of Mexico indicate a wide variety of demographic, employment, income, land-use, and infrastructure patterns. These reflect heterogeneous sociocultural systems in areas ranging from the Texas coast to the Florida Keys. This rich diversity is evident in a myriad of cultural centers, including the Hispanic enclaves of south Texas, the Acadian "French Triangle" of south Louisiana, the Vietnamese communities of coastal Louisiana and Mississippi, and the Greek residents of Florida's Tarpon Springs. Involvement in oil and gas activities is uneven along the Gulf Coast. Some areas are heavily involved, while many others exhibit little or no involvement. Sociocultural diversity and differing levels of involvement make it difficult to predict how a particular area will respond to changes in oil and gas industry activity levels. Largely due to MMS studies, there is a nascent line of socioeconomic work which aims to understand the impact of offshore oil and gas development on onshore human populations.

Since World War II, coastal economies with substantial involvement in oil and gas industry activity have echoed the ups and downs of that industry's business cycles. McKenzie et al. (1993) notes that the association between coastal economies and industry performance depends as much on the fate of onshore oil and gas as it does on the offshore oil and gas industry. Still, the few early socioeconomic studies of the western and northern Gulf region found substantial evidence of aggregate effects associated with "boom" and "bust" episodes in the oil and gas industry. These effects include rapid in- and out-migration (Gramling and Brabant, 1986), volatility in social problems indicators (Seydlitz and Laska, 1994), pressure on local infrastructure (Laska et al., 1993), and volatility in income inequality patterns (Tolbert, 1995). A few more recent research projects have focused more closely on specific coastal communities. Tolbert and Shihadeh (1995) found substantially different income inequality patterns across the 1950-1990 period for three neighboring coastal Louisiana towns. One community's income patterns over time reflect the same sort of volatility that is evident in the aggregate for the region as a whole. Another nearby community exhibits substantially less volatility and appears to have weathered the industry downturn rather well. In a follow-up community case study, Tootle et al. (1999) attributed the resilience of a community in the heart of oil and gas country to industrial diversity and social resources rooted in dense social networks based on kinship, culture, and other enduring relationships. These researchers posit that industrial diversity and dense social networks bolster local economies and cushion the effects of sharp economic downturns. Their longitudinal study yields evidence that the rural community weathered not only the expansion and contraction of the offshore oil and gas industry, but also the closing of a large manufacturing establishment and a serious downturn in agriculture.

While much more research is needed–and several important USDOI, MMS studies are in progress–the recent research suggests that the historical effects of offshore oil and gas activities on the sociocultural environment have not been sweeping regional effects. The effects vary from one coastal community to the next. In some cases, the social organization of communities leaves them vulnerable to fluctuations in industry activity. In other cases, the local sociocultural structure buffers communities from industrial ups and downs of all sorts–not the least of which is encountered by the offshore oil and gas industry. In the face of expansions or contractions of offshore (or onshore) oil and gas activity, sociocultural systems in some communities experience intense stress. Other communities have the capacity to weather episodes of rapid industry change and may even thrive in doing so.

Environmental justice is a recent mandate not addressed by the National Research Council (NRC) 1992, or Gramling and Laska (1993). However, the question of who benefits and who is burdened from a proposed action has always been part of the assessment process and has been addressed by past studies. *A Socioeconomic Baseline Study for the Gulf of Mexico*, *Phase I* (Louisiana State University, Coastal Marine Institute, ongoing) collected relevant county-level economic and demographic data since 1930 for all Gulf Coast States. *An Assessment of the Historical, Social, and Economic Impacts of OCS Development on Gulf Coast Communities* addressed this issue from a long-term perspective. Its contribution lies in placing the effects of the oil industry within the context of Southern history. Two other significant MMS works are *Labor Migration and the Deepwater Oil Industry* (Louisiana State University, Coastal Marine Institute, ongoing), which looks at legal alien labor in the fabrication industry that resulted from deepwater demand, *and Job Loss and Reemployment of Marginal Groups in the GOM Region* (Louisiana State University, Coastal Marine Institute, ongoing) that analyzes differential effects of the 1980's downturn and upturn on women and minorities.

Two ongoing studies will provide tools for analyzing this issue. The *OCS-Related Infrastructure in the Gulf of Mexico* study is developing a Geographical Information System (GIS) module for locating and describing existing facilities, including those such as waste-disposal sites and pipeline landfalls that are deemed critical to assessments of possible disproportionate health effects on low-income or minority people. This module will be integrated into MMS's existing GIS system. In addition, *Benefits and Burdens of OCS Deepwater Activities on Selected Communities and Local Public Institutions* is collecting county-level demographic and economic data, including information on low-income and minority people. Its commuting zone analysis addresses industry effects on these populations.

Data on annual per capita income from the USDOC, Bureau of Economic Analysis, can be used to assess the relative socioeconomic well-being of area residents. Per capita income is defined as the ratio of an area's total personal income to the total population. For 1998, the State per capita incomes were as follows: Texas ($25,369), Louisiana ($22,062), Mississippi ($19,776), Alabama ($22,054), and Florida ($26,854). To identify low-income counties, the ratio of a particular county's per capita income to its State per capita income was calculated. A ratio value less than one means that the county is below the State norm, and a value greater than one means the county's local income exceeds that typical of the State as a whole. There are three counties with ratios less than 0.5: Union (Florida), Starr (Texas), and Willacy (Texas). These are very low-income counties, as the local per-person income does not equal one-half of the Statewide norm. About one-third of all the counties fall between 0.5 and 0.75 on the ratio. These can be construed as moderately low-income locales. They cluster in the panhandle of Florida, inland areas of east Texas, and near the border in south Texas. Near- to above-average per capita incomes are indicated from the Brazoria, Texas, LMA eastward to Pensacola, Florida. Higher incomes are also evident on the Gulf coast of Florida from Tampa-St. Petersburg to the south.

Potentially vulnerable racial and ethnic populations also reside in the three Gulf of Mexico Planning Areas. Tables 3-13 indicates the substantial proportions of African-American and Hispanic persons along the coast. The Hispanic population tends to be concentrated in Texas and south Florida. The African-American population makes up a significant proportion of the population along the central Gulf Coast. Another minority group of concern is Native Americans. Using 1999 estimates from the Bureau of the Census, it is possible to identify counties where there are significant populations of Native Americans. While most of the percentages are quite small—three-quarters are 0.5 percent or less—there are a handful of counties with more than a 2-percent Native American population. The Mowa Choctaw tribe of Washington County, Alabama, constitutes 5 percent of the county population. The United Houma Nation represents 4 percent of the population of Terrebonne Parish, Louisiana, and just over 2 percent of Lafourche Parish. The Alabama-Coushatta tribe is 2 percent of the population of Polk County, Texas. Increased oil and gas activities in these areas could affect these Native American populations. Lafourche Parish, especially, is already serving as one of the few deepwater servicing facilities on the Gulf Coast.

3.1.3.6. Archaeological Resources

3.1.3.6.1. Prehistoric Resources

At the height of the late Wisconsinan glacial advance (approximately 19,000 years ago) global (eustatic) sea level was approximately 120 m lower than present. During this time, large expanses of what is now the OCS were exposed as dry land. According to the sea-level curve proposed for the northern Gulf of Mexico by Coastal Environments, Inc. (CEI, 1982), sea level would have been approximately 45 m lower than present at 12,000 B.P. (Before Present), the earliest date prehistoric human populations are known to have been in the Gulf Coast region (Aten, 1983). The location of the 12,000 B.P. shoreline is roughly approximated by the 45-m bathymetric contour. The continental shelf shoreward of this contour would have potential for prehistoric sites dating subsequent to 12,000 B.P. Since known prehistoric sites on land usually occur in association with certain types of geographic features, prehistoric sites should be found in association with those same types of features now submerged and buried on the continental shelf.

Geographic features that have a high potential for associated prehistoric sites in the western and central Gulf (from Texas to Alabama) include barrier islands and back barrier embayments, river channels and associated floodplains, terraces, levees and point bars, and salt dome features. In the

Tertiary karst region of the eastern Gulf of Mexico, off the coast of Florida, additional features such as solution caverns, sinkholes, and flint or chert outcrops also have potential for associated prehistoric sites. Remote sensing surveys, which have been required on leases shoreward of the 45-m contour, have been very successful in identifying these types of geographic features that have a high probability for associated prehistoric sites.

Regional geologic mapping studies by the USDOI, MMS have provided a geologic framework to aid in the interpretation of lease block survey data. This regional framework allows interpretations to go beyond identification of relict geomorphic features to an assessment of their archaeological potential in terms of their general age, the type of system to which they belong, and the geologic processes that formed and modified them.

In addition to identifying areas with a high probability for site occurrence, the potential for site preservation must also be considered. In general, sites covered by sediments in a low-energy environment (i.e., floodplains, bays, lagoons, river terraces, and subsiding deltas) prior to the sea's transgression of the area will have a high degree of preservation. Other protected areas (i.e., depressions, ponds, lakes, and sinkholes) and areas subjected only to low wave energy also would favor site preservation.

In 1986, the USDOI, MMS, funded a study to test the adequacy of the existing methods and technology to locate prehistoric archaeological sites on the OCS. The study area was the buried ancient Sabine-Calcasieu River Valley offshore southwestern Louisiana and southeastern Texas (CEI, 1986). Existing high-resolution seismic and borehole data were reviewed to identify specific geomorphic features such as individual channels and terraces in association with the river valley that would have a high potential for prehistoric archaeological sites. Additional high-resolution seismic data were then collected to further detail the most promising areas. The areas identified from the seismic data as having the highest potential for prehistoric sites were then physically sampled using a series of vibracores. The study attempted site identification through laboratory analysis of the core material. These sedimentary analyses suggest the presence of at least two archaeological sites buried 4.5-6.5 m below the seafloor at the locations tested (CEI, 1986).

In 1999, the USDOI, MMS completed a study of archaeological materials recovered from McFaddin Beach, Texas, a 32-km-long stretch of the southeast Texas coastline just onshore from the ancient Sabine River Valley (Stright, et al. 1999). The study concluded that the artifacts were eroding out of the shore face just offshore the present coastline. Since the coastline has been rapidly eroding for many years, the implication is that the basal portions of many archaeological sites may still be lying just offshore this coastal area.

Archaeological investigations in the Apalachee Bay region of Florida have produced 17 inundated prehistoric sites (Dunbar, et al., 1989). The majority of the identified sites have been within State waters. However, human cultural debris (a possible secondary retouch flake) was discovered at Ray Hole Spring, a karst sinkhole, located in Gainesville Area, Block 177, approximately 37 km south of Jefferson County, Florida, on the Federal OCS (Anuskiewicz and Dunbar, 1993).

3.1.3.6.2. Historic Resources

Although most historic archaeological resources on the OCS are shipwrecks, other types of historic sites such as the Ship Shoal Lighthouse may occur in Federal waters. A literature search for reported ship losses and known shipwrecks was conducted as part of the archaeological resources baseline study for the northern Gulf of Mexico (CEI, 1977). This study indicated that less than 2 percent of pre-20th century ships reported lost in the Gulf and less than 10 percent of all ships reported lost between 1500 and 1945 have known locations (110 out of 1,589). Considering the problems with inaccurate wreck reporting, drift and breakup of wrecks, and ships that have been lost but never reported, it becomes apparent that very little is really known about the locations of historic shipwrecks in the Gulf.

To deal with the management problems of this largely unlocated resource base, a high-probability zone for shipwreck occurrence (Zone 1) was proposed by the baseline study (CEI, 1977). This zone was initially delineated by using geographic factors (such as approaches to seaports, straits, shoals, reefs, and historic shipping routes) as indicators of high shipwreck potential.

In 1989, Texas A&M University completed a study for the USDOI, MMS that updated and expanded the list of historic shipwrecks developed by CEI (Garrison et al., 1989). This investigation identified over 4,000 potential shipwreck locations in the Gulf, nearly 1,500 of which occur on the OCS. The study also investigated the relationship between factors such as ocean currents, storm tracks, natural navigational hazards, the economic history of port development and usage, and the distribution of shipwreck patterns. The results of these analyses indicate that many of the shipwrecks on the OCS occur in clustered patterns related mainly to navigation hazards and port entrances. As a result of this study and ongoing ground-truthing investigations by the MMS Gulf of Mexico regional archaeologists, the high probability areas for the occurrence of shipwrecks continue to be refined (Figure 3-21). The USDOI, MMS is currently funding another study to further refine the areas of shipwreck potential in the Gulf of Mexico.

Once a ship goes down, the spatial distribution of site materials (integrity/preservation of the site) is governed by sea state, water depth, type of bottom, nature of the adjacent coast, strength and direction of storm currents and waves, and the size and type of the vessel. The 1989 study by Garrison et al. investigated how these variables affect shipwreck preservation potential.

The study concluded that preservation potential throughout the northwestern Gulf is expected to be moderate to high. The major factor that would affect the integrity of shipwreck sites in the north-central Gulf is the Holocene deltaic sediments, which have been deposited by the Mississippi River. A thick blanket of unconsolidated, organic-rich sediments would protect site components as they settled. Due to differences in sedimentation rates across the north-central Gulf, it is expected that preservation potential in the eastern part of this area (off Mississippi/Alabama) will be higher than the preservation potential in the western part (off Louisiana).

High concentrations of shipwrecks occur off Florida's west coast from Pensacola to the Apalachicola/ Cape San Blas areas. In general, higher numbers of shipwrecks were reported throughout the planning area than were previously realized (Garrison et al., 1989). The major factors that would affect the integrity of wreck sites in this area are the broad, gently sloping shelf, the relatively low wave energy, and the carbonate sands on the seafloor. Ships that sank in this area are not considered to have a high potential for preservation because of the low sedimentation rates that occur here. Shipwrecks on the seabed would be exposed to decay and deterioration in the oxygenated bottom waters and to strong currents from the occasional tropical storm that traverses the area. Exceptions to low preservation potential would be in localized coastal areas where active sand deposition was occurring. Although little data currently exist to test this hypothesis, it is reasonable to expect that much of this area will be characterized by poor preservation of historic shipwrecks.

3.2. Alaska Region

3.2.1. Physical Environment

3.2.1.1. Geology

The Beaufort Sea, Chukchi Sea, and the Hope Basin Planning Areas (Figure 2-3) are located in the arctic region of Alaska. Planning areas in the Beaufort and Chukchi Seas include the continental shelf, slope, borderlands (transitional continental to oceanic crust), and the abyssal plain of the Arctic Ocean. The following discussion summarizes more detailed reports found in Sharma (1979), Craig et al. (1985), Scherr et al. (1991), U.S. Army Corps of Engineers (1997), and U.S. Army Engineer District, Alaska (USAED) (1999) for the Beaufort Sea; Sharma (1979) and Thurston and Theiss (1985) for the Chukchi Sea; and Sharma (1979) and Tolson (1987) for the Hope Basin.

The Beaufort Sea continental shelf is relatively narrow and most of the planning area lies in the abyssal plain of the Arctic Ocean. The abyssal plain bounds the Beaufort continental shelf to the north from the Alaska-Yukon border to the Barrow Canyon. The distance from shore to the shelf break ranges from 55 to 110 km. Barrier islands and shoals are common on the Beaufort shelf.

The Chukchi Sea is a broad, shallow embayment of the Arctic Ocean. Most of the Chukchi Sea Planning Area is located on the continental shelf, but a continental borderland occurs north of about 73^{o} N. latitude. The floor of the Chukchi Sea is a broad, northerly inclined, continental shelf in water depths generally less than 61 m. The heads of three subsea valleys lie north and west of Point Barrow. The northern shelf is underlain by Pleistocene sediments that were extensively channeled and subsequently filled.

The Hope Basin is a prominent geological basin beneath the continental shelf of the southern Chukchi Sea between Point Hope and the Bering Strait. It is an extensional rift basin that runs from the southeast to northwest along the Alaskan and Chukotkan coasts. Water depths in the basin vary from 35 to 55 m.

Sea ice scour is a dominant process affecting the seafloor of the Beaufort and Chukchi shelves. Scour of the seafloor occurs to a maximum water depth of 60 m, caused by deep keels of icebergs moving across the shelf. Sediments are scoured to depths of as much as 3 m. Strudel scouring of the seafloor occurs near the mouths of rivers during spring flood periods. Subsea permafrost may be present in the Beaufort Sea Planning Area but has not been identified beneath the Chukchi Sea/Hope Basin shelf.

Northern Alaska can be divided into two major petroleum provinces: a landward province that contains Paleozoic, Mesozoic, and Tertiary strata deposited on continental basement rock and underlain by continental crust, and an offshore province that contains a thick clastic wedge of Cretaceous and Tertiary sediments deposited on the subsiding continental margin. The boundary between the two provinces lies along a zone of basement faulting informally termed the Hinge Line. The Hinge Line represents the southern limit of rifting that occurred during the late Mesozoic. The Arctic Platform is the gently southward-dipping surface of the continental basement rock (Figure 3-22).

Four stratigraphic sequences are recognized in northern Alaska. The Franklinian sequence comprises the acoustic and economic basement of the Arctic Platform and is Precambrian to Middle Devonian in age. The basement complex is overlain by the Ellesmerian sequence, of Late Devonian to mid-Jurassic Age, composed of clastic and carbonate rocks deposited in a stable shelf environment. The

Ellesmerian sequence is overlain by the Rift Sequence of Late Jurassic to Early Cretaceous Age composed of marine sandstone and shale deposited on a stable shelf environment. Ellesmerian sedimentation terminated in Early Triassic time with the onset of uplift and rifting in the vicinity of the present continental margin. The Beaufortian sequence rocks are early Jurassic to early Cretaceous Age. Subsidence of the offshore continental margin in Cretaceous and Tertiary time created the Nuwuk and Kaktovik Basins (Figure 3-22), deep structural basins beneath the present Beaufort shelf. An immense clastic wedge of Brookian sequence rocks prograded northward from the Brooks Range rock, filling the Colville Basin and the deep basins offshore. Deposition of Brookian sediments started in early Cretaceous and continues today.

Four major sedimentary basins occur in the Chukchi Sea/Hope Basin Planning Areas (Figure 3-22). The Ellesmerian-age Central Chukchi Basin is a northtrending, offshore extension of the Arctic Alaska Basin and contains up to 12,000 m of layered carbonate and clastic deposits. The North Chukchi Basin contains more than 13,500 m of lower and upper Brookian strata. The Northeast Chukchi Basin contains more than 13,700 m of Paleozoic sediments, and the Hope Basin contains up to 5,600 m of Late Cretaceous to Quaternary clastic deposits. Additionally, the Central Chukchi Basin contains two younger subbasins, the Colville Subbasin which contains 6,000 m of lower Brookian clastic deposits, and the Northcentral Subbasin which contains 2,500 m of upper Brookian, stratified, clastic rocks.

Persistent structural platforms include the Chukchi Platform in the western part of the Chukchi Planning Area and the Arctic Platform flanking the southern part of Beaufort Sea Planning Area. These platform areas have influenced sedimentation patterns from late Devonian to Cenozoic time. In the northeast is the North Chukchi high, of Late Cretaceous to Tertiary Age. Additional structural features include the Late Devonian to Early Mississippian Barrow, Wainwright, and Northeast Chukchi fault zones; the Early to Late Cretaceous fold and thrust belt; and the Late Cretaceous to Tertiary Herald Arch, Herald thrust fault, Hanna wrench-fault zone, and diapirs. Numerous local features are associated with the Hanna wrench-fault zone, including flower structures and tectonic upwarping and sagging.

The Cook Inlet/Shelikof Strait and Gulf of Alaska Planning Areas are located in the subarctic region of Alaska (Figure 2-4). Descriptions of the geology of these areas are summarized from Fisher et al. (1987), Plafker (1987), Von Huene et al. (1987), Horowitz et al. (1989), and USDOI, MMS (1996a, c; 1996d). Norton Basin, also located in the subarctic region south off the coast of the Seward Peninsula (Figure 2-5), is summarized here from the descriptions of Banet (1998), Fisher et al. (1982), and Turner et al. (1986).

The Cook Inlet is an elongated bay on the southern coast of Alaska with very strong tidal forces. The length of the inlet is about 300 km, running northeast-southwest. The width varies from 16 km at the Forelands to over 70 km near Homer. Water depths range from extensive mud flats in the upper inlet to depths of over 80 m at the southwestern end of the inlet. The inlet opens to the Pacific Ocean past the Barren Islands on the east side of Kodiak Island, and through Shelikof Strait on the west side. Shelikof Strait is a body of water running northeast-southwest between Kodiak Island and the Alaska Peninsula. It is about 200 km long, with an average width of about 45 km. Water depths increase slowly toward the southwest from about 80 m at the mouth of Cook Inlet to over 300 m off the west end of Kodiak Island.

A belt of Mesozoic and Cenozoic sedimentary rocks underlie the upper Cook Inlet on the northeast and the Alaska Peninsula on the southwest. Cook Inlet is flanked by four major geologic features with northeast trends: the Alaska-Aleutian Range batholith and the Bruin Bay fault on the northwest side, and the Border Ranges fault and the terrain of undifferentiated Mesozoic and Cenozoic rocks on the southeast side. The Augustine-Seldovia Arch, which is oriented east-west transverse to the primary structural trend separates two depocenters. The northern depocenter in upper Cook Inlet contains as much as 7,600 m of Cenozoic strata. The southern depocenter in lower Cook Inlet and Shelikof Strait contains a thin veneer of Cenozoic strata over as much as 11,000 m of Mesozoic strata. Figure 3-23 provides a generalized map of these features.

The northeastern Gulf of Alaska extends 500 km from Cross Sound northwest to Kayak Island. The width of the continental shelf narrows from about 100 km in the southeast to 30 km near Kayak Island. Onshore topography to the north is very rugged, containing some of the largest glaciers and tallest mountains in North America. Offshore, the continental shelf and slope range in width from 15 km in the southeast to over 100 km off Icy Bay. The shelf bathymetry is gently undulating except where it is broken by six major and other smaller submarine valleys formed during the Pleistocene. The continental shelf is bounded to the south and the west by a steep continental slope into the North Pacific abyssal plain. The broad boundaries of the planning area include all of these physiographic provinces, although petroleum activities are expected to occur primarily on the continental shelf.

Several tectonic terranes are recognized along the northern shelf of the Gulf of Alaska. These terranes are separated by complex traverse fault zones that trend northeast to the southwest across the shelf. The terranes on the continental shelf are separated from oceanic crust under the Pacific basin by the Transition zone marking the transform boundary between the North Pacific and North American Plates. This complex area extends into the north end of the Aleutian Trench, where subduction has widened the north end of the terrane into a zone of thrust faults and folds. The rocks of the Yakutat Terrane are primarily Late Cretaceous to Pleistocene Age marine strata. A clastic sedimentary sequence that may be Miocene or younger occurs along the upper slope.

Norton Basin is approximately 125 miles long and ranges from 30 to 60 miles in width. Water depths within the planning area generally range from about 5 to 55m. The geologic basin formed during late Cretaceous to early Tertiary time by extensional rifting processes related to basement formation when the underlying rocks subsided during an extension or pulling apart of the earth's crust along a major fault system. Prior to the start of the extensional event, the Paleozoic-to-Mesozoic rocks that form the present basement of the Norton Basin were deformed and heated to the extent that they probably were not capable of generating hydrocarbons when the Basin was formed.

Norton Basin is divided into two subbasins (St. Lawrence in the west and the Stuart in the east) which are separated by a basement ridge referred to as the Yukon Horst. The subbasins existed as discrete depocenters from Paleocene to middle Oligocene time. The depositional environments for the sediments that accumulated in the two subbasins range from continental to upper bathyal marine. From the late Oligocene to the present, a shelf environment much like that of the present-day Norton Sound characterizes the Basin, with paleobathymetry ranging from transitional marine to middle neritic. Analysis of the geochemical data collected from deep stratigraphic test wells (continental offshore stratigraphic wells) indicate that Norton is most likely a gas-prone basin.

3.2.1.2. Meteorology and Air Quality

Climate

The climate of Alaska is varied because of the large differences in latitude and geography. A climate classified as tundra is found around the Beaufort and Chukchi Seas, while a temperate, rainy climate is found along portions of the Gulf of Alaska. Along the Arctic Ocean, the average winter temperature ranges from -18 to -29 °C (0 to -20 °F). Extreme temperatures as low as -49 °C (-56 °F) have been recorded at Barrow. In the summer months, there is frequent cloudiness, fog, and drizzle. In the warmest month, the average temperature ranges from about 5 °C (40 °F) along the Beaufort Sea to near 10 °C (50 °F) around the Hope Basin. There is small diurnal variation in temperature in both winter and summer. The average annual precipitation ranges from 10 to 20 cm (4 to 8 inches), mostly as rainfall during the summer months. In all seasons except summer, atmospheric pressure at the surface decreases from north to south. The Beaufort Sea coastal winds are usually easterly and are strongly influenced by channeling due to the Brooks Range to the south. In the eastern portion of the Beaufort Sea around Barter Island, westerly winds become more frequent in the summer and fall months. In the Chukchi Sea and the Hope Basin, the mean wind direction over the year is more northeasterly, but reverses to southwesterly in the summer.

Along the Norton Basin and the Bering Sea, average temperatures in the winter range from about -18 to -12 °C (0 to 10 °F). In the summer, the average temperature is around 10 °C (50 °F). The average annual precipitation ranges from around 30 cm (12 inches) around the Bering Strait to 80 cm (32 inches) along portions of Bristol Bay. The most precipitation occurs in late summer and early fall. A major influence on the Bering Sea climate is the Aleutian Low, which is especially pronounced in the winter season. In the summer, low pressure moves to the north and is centered in the Bering Sea.

The climate of the coastal areas along the Cook Inlet and the Gulf of Alaska borders between the cold snow-forest and the temperate rainy climate types with cool summers. The average winter temperature ranges from -12 to -6 °C (10 to 20 °F), while the average summer temperature is around 12 °C (54 °F). The amount of precipitation depends strongly on the surrounding topographic features. The average annual precipitation ranges from about 60 cm (24 inches) around the Cook Inlet to 375 cm (150 inches) at locations in the Alaska Panhandle that have the most exposure to moist, westerly winds. Precipitation falls throughout the year, but is greatest in the fall and winter. Winds are strongly influenced by local topography and mostly blow parallel to nearby mountain ranges. In the Cook Inlet, the predominant wind direction is from the northeast. In the Gulf of Alaska, the prevalent wind direction is from the east.

Major storms are common in the Gulf of Alaska. They are most frequent and intense in winter. Major storm tracks lie along and south of the Aleutian Islands and Alaska Peninsula. The storms generally move eastward and stagnate near southeast Alaska. Winds up to 40 m/sec (90 mph) and wave heights to 15 m (50 ft) may accompany these winter storms. Intense coastal winds occur as a result of atmospheric pressure differentials between interior Alaska and the Gulf of Alaska. Higher interior atmospheric pressure also promotes periodic, local, offshore winds that are orographically funneled, attaining velocities up to 150 kilometers per hour (km/hr) (94 mph) and extending up to 30 km (18 miles) offshore (Lackmann, 1988).

Atmospheric stability provides a measure of the amount of vertical mixing of any air pollutants in the lower atmosphere. Along the Arctic Ocean as well as the Gulf of Alaska, the atmospheric stability is predominantly neutral. This is due to the frequent occurrence of relatively high wind speeds and cloud cover. Stable conditions are found about 15-25 percent of the time, while unstable conditions occur less than 10 percent of the time. The stable conditions are associated with clear, calm conditions at night. Over open water in the wintertime, unstable conditions are expected to be more frequent. The presence of sea ice would tend to result in more stable conditions, but also somewhat higher wind speeds. More stable conditions are expected over water in the summer season because of the relatively colder temperature of the sea surface in relation to the ambient air.

Air Quality

The existing air quality in Alaska is considered to be relatively pristine, with pollutant concentrations in most areas that are well within the NAAQS. Alaska has the lowest air emissions of all the U.S. States. There are few industrial emission sources and, outside Anchorage or Fairbanks, no sizable population centers. The primary industrial emissions are associated with oil and gas production, power generation, small refineries, paper mills, and mining.

Most air emissions on the plains bordering the Arctic Ocean are associated with oil production and pipeline transportation centers around Prudhoe Bay. Ambient monitoring has been conducted in that area for NO_2, SO_2, PM_{10}, CO, and ozone. The measured ambient concentrations are all well within the NAAQS.

During the winter and spring, a phenomenon known as arctic haze occurs in northern Alaska. It is believed that this is caused by long-range pollutant transport from industrial Europe and Asia (Rahn, 1982). Fine particulate matter builds up in the lower atmosphere due to the stable atmospheric conditions and limited mixing that is characteristic of the arctic winter. At Barrow, sulfate concentrations due to arctic haze average about 1.5 micrograms per cubic meter ($\mu g/m^3$) above background levels. The concentrations of vanadium, a combustion product of fossil fuels, average up to 20 times the background levels both in the air and in the snowpack. Concentrations of aerosol haze during winter and spring at Barrow are similar to those observed over large portions of the continental United States, but they are considerably higher than levels south of the Brooks Range of Alaska. Despite this seasonal long-distance transport of pollutants into the arctic, regional air quality still is far better than specified by the NAAQS and the State standards.

The Federal standard for CO is exceeded in parts of Anchorage and Fairbanks. The primary source of CO is emissions from motor vehicles. The PM_{10} standard is exceeded in Anchorage, the Mat-Su Valley, and Juneau. The most important sources of particulate matter in Alaska include volcanic ash, wind blown dust from dry glacial riverbeds, dust from unpaved roads, re-entrainment of winter sanding materials from paved roads, and wood smoke.

All areas that meet the NAAQS are designated either Class II or Class I under the PSD regulations. There are four Class I areas in Alaska. These are Bering Sea National Wilderness Area (NWA) located on St. Matthew Island in the Bering Sea; Simeonof NWA in the Shumagin Islands off the Alaska Peninsula; Tuxedni NWA in the Cook Inlet; and Denali National Park. The Bering Sea, Simeonof, and Tuxedni Class I areas are national wildlife refuges administered by the USDOI, FWS. The Denali Class I area is administered by the National Park Service. The Tuxedni NWA is the only Class I area that is located in close proximity to any potential OCS development under the proposed 5-year program. Figure 3-24 shows the location of the Tuxedni NWA in relation to the Cook Inlet Planning Area.

3.2.1.3. Physical Oceanography

The Beaufort and Chukchi Seas are marginal seas of the Arctic Ocean (Figure 2-3). The Beaufort Sea extends along the Alaskan and Canadian coast between Banks Island in the Canadian high arctic and Point Barrow, Alaska, on the west. The Chukchi Sea is a triangular sea bounded by the Arctic Ocean, the northwestern coast of Alaska, and the northeastern coast of Siberia.

Information on circulation in the Arctic Ocean, the Beaufort Sea, and the Chukchi Sea was provided by Dr. Andrey Proshutinsky at an MMS seminar in Anchorage, Alaska, on June 1, 2000, as well as by Sharma (1979), Lissauer et al. (1984), and Colonell and Niedoroda (1988). The Arctic Ocean, through the processes described below, controls average temperatures and net current and ice movement throughout the arctic, including the Beaufort and Chukchi Seas. Circulation in the Arctic Ocean is dominated by atmospheric conditions. Three water masses can be identified in the Arctic Ocean. Arctic surface water is typically found to a depth of 200 m, Atlantic Ocean water is typically found at 200-900 m, and arctic bottom water is found at depths greater than 900 m. The current structure of the Arctic Ocean has two alternating stable states. Cyclonic (counterclockwise) winds centered over the central Arctic Ocean predominate for 5-7 years, alternating with anti-cyclonic (clockwise) winds for comparable time periods. Higher atmospheric pressure over the central arctic during cyclonic wind conditions depresses the water surface, allowing warmer subsurface Atlantic Ocean water to reach the surface, raising average air and water temperatures throughout the arctic. Under the same winds (cyclonic), the general ice circulation moves in a counterclockwise direction. When anti-cyclonic winds predominate, both the air and water are colder, and ice and water circulate in a clockwise direction under the control of surface winds. When the Arctic Ocean is dominated by a cyclonic weather regime, winds in the Beaufort and Chukchi Seas tend to be stronger, and the water tends to be warmer in winter. Under an anti-cyclonic regime, winters tend to be colder, and summers warmer, although less so in the Beaufort Sea.

Several physical factors control currents in the Beaufort Sea. The Alaska Coastal Current flows from west to east along the shelf break in the Beaufort Sea (Figure 3-25). It may be found at the surface, but is primarily a subsurface current. It is found to a depth of about 200 m. Surface current structure in the nearshore is dominated by winds. Surface currents can change direction in as little as 3 hours, depending on surface wind direction and strength. Current velocity is reported as 2-3 percent of wind speed. In shallow water (less than 7-m depth), current direction closely follows wind direction. In waters greater than 7 m, the Coriolis effect moves water to the right of the wind direction. Under west wind conditions, surface water piles up on shore, pushing nearshore surface water down and offshore. This produces warmer than average conditions. Easterly winds push surface water offshore, resulting in upwelling of cold subsurface water.

The current structure in the Chukchi Sea is controlled by two water masses entering through the Bering Strait and Siberian water moving southeast along the Siberian coast (Figure 3-25). These two water masses are the Alaska Coastal Current on the east and the Bering Sea water mass on the west. The volume of water entering the Chukchi Sea through the Bering Strait was estimated to be 800,000 cubic meters/second(m^3/s), with two-thirds of that occurring during the summer. Net motion of water through the Chukchi Sea is to the north. When the Alaska Coastal Current enters the Chukchi Sea, it flows through the Hope Basin, northeast along the Alaska shoreline to Point Barrow, and then east into the Beaufort Sea. The Bering Sea water mass coming through the Strait mixes with the Siberian Current and flows north and west through the Chukchi Sea, passing through the western part of the Hope Basin along the way (Sharma, 1979).

Current structure throughout the arctic during winter is complex and is apparently driven by variations in atmospheric pressure. Net motion during the winter is to the west in the Beaufort Sea and to the north through the Chukchi Sea. During the winter, the Alaska Coastal Current continues to flow northeast along the Chukchi coast and to the east as a subsurface current in the Beaufort Sea, but usually at reduced velocity.

Tidal information comes from International Marine (2000a). Tides in the Beaufort and Chukchi Seas are mixed semidiurnal. They are minimal when compared to those found further south in Alaska. The highest tide for the year 2000 at Prudhoe Bay, on the Alaskan Beaufort coast, was 43 cm in July. The lowest tide was -18 cm in March. There is a strong annual signal to the tides, with the highest tide in the summer and the lowest in spring, as compared to the more typical condition with the highest and lowest co-occurring. Tides throughout the Beaufort and Chukchi Seas are similar to Prudhoe Bay. Storm surges change water levels along the arctic coast by much greater amounts.

Water levels may rise or fall by as much as 3 m under the effects of storm surges. Nuiqsut whaling captains have observed that these storm surges occur with southwesterly winds, not during northeast winds (T. Napageak, Nuiqsut Whaling Captains meeting, August 13, 1996). Tidal currents are not reported for the Arctic Ocean, so those data are not available.

Waves in the Arctic Ocean are controlled by wind and ice. The energy to build waves comes directly from prevailing winds. However, the fetch (distance the wind has to act on the water surface) over which the wind has an effect is determined by ice conditions. With a solid ice cover, there are no waves generated. Under heavy ice-cover conditions, during the open water season, there is little wave development. When the ice thins out, particularly during late summer, the available water surface increases, and the waves grow in height. Typical wave heights are less than 1.5 m with a period of approximately 6 seconds during the summer, and less than 2.5 m during the fall. Expected maximum wave heights are 7-7.5 m in the Beaufort Sea and 8-9.5 m in the Chukchi Sea (Brower et al., 1980). Wave periods ranged from 6 to 12.8 seconds (Offshore and Coastal Technologies, Inc. 1996, as cited in USAED, 1999). A late summer storm in the Beaufort and Chukchi Seas in September 2000 was reported in the popular press to have developed waves 6-7 m high at Point Barrow. Typical wave heights are less than 1 m during the open-water period.

Sea ice dominates the arctic marine environment. The U.S. Beaufort and northern Chukchi Sea coastlines are typically ice-free for only 2-4 months each year. Breakup in the Beaufort Sea, the period in spring when the ice melts, starts with an input of warm fresh river water from snow and ice melting off terrestrial habitats. A freshwater lens spreads along the shorelines from the river deltas, melting off the shallow shorefast ice. At the same time, the heat of the returning sun starts melting the pack ice offshore. The sea ice melts or is blown offshore far enough to allow vessel navigation in late July or August; it returns in September or early October, ending the open-water season. However, pack ice can be present at any time during summer if winds blow from the north or northwest. Sea ice is often used for travel during the winter.

The southern Chukchi Sea is free of sea ice for 1-2 more months each year. Warmer water flowing north through the Bering Strait, combined with strong sunlight returning earlier in the year at lower latitudes, melts or pushes the pack ice north starting as early as mid-June. The same effect keeps the surface ice free longer in the fall, typically until mid-November.

New sea ice in the arctic grows to a thickness of 2-3 m over the course of a winter. Multi-year ice may be much thicker. The outer edge of the landfast winter ice, the Stamukhi zone, is where most ridge building and gouging occur. Pressure ridges, caused by collisions of large ice islands moving in different directions, build to a sufficient thickness to gouge the bottom. Typically this occurs in 15-40 m of water, but may be seen in as little as 8 m or as much as 60 m of water. Offshore of this is the pack-ice zone, with large smooth pans of ice.

Alaskan Natives have amassed a great deal of traditional and local knowledge about sea ice conditions. However, it is very context dependent and difficult to separate or index into its analogous "scientific" components. The MMS is currently funding a project to compile such an index for publicly available North Slope traditional and local knowledge, for which sea-ice conditions are one category. A recent conference on changes in arctic sea ice as a measure of global climate change included the participation of Alaskan Natives as a vital component (Marine Mammal Commission, 2000). North Slope Borough (NSB) Elder's Conferences often contain this sort of information (for example, Okakok and Kean, 1981), as does the testimony associated with previous Beaufort Sea lease sale EIS's.

Cook Inlet is a deep fjord that opens at its south end into the Gulf of Alaska. It is bounded on the east by the Kenai Peninsula, on the north by southcentral Alaska, and on the west by the Alaska Peninsula. The Gulf of Alaska can be roughly defined as a semi-elliptical water mass bounded on the north by the Alaska shoreline from southeast Alaska west to the tip of the Alaska Peninsula. The eastward flowing Subarctic Current in the North Pacific Ocean bounds the Gulf of Alaska on the south.

Circulation in Cook Inlet is dominated by two forces. Seawater enters the inlet from the Gulf of Alaska south of the Kenai Peninsula, and fresh water enters the inlet from numerous streams along the east, north, and west shorelines. Major inputs include the Susitna and Kenai Rivers. Numerous smaller streams (such as the Little Susitna, the Kasilof, and the Chakachamna Rivers) add additional fresh water and silt. Net flow of water is in a counterclockwise direction (Figure 3-26), with seawater flowing north along the Kenai Peninsula in the lower inlet. In the upper inlet, currents are dominated by tidal currents. Despite the salinity differences in the southern oceanic and northern riverine water masses, strong currents in the northern inlet mix the entire water column. After mixing in the north inlet, net flow of the current is south along the west side of the inlet. Net flow out of the inlet is through the Shelikof Strait between the Alaska Peninsula and Kodiak Island, where it empties into the Gulf of Alaska.

There is a primary counterclockwise circulation pattern, or gyre, through the northeastern Gulf of Alaska. As the eastward flowing Subarctic Current approaches the coastline of North America, the Alaska Current separates and flows in a counterclockwise direction to the north into the Gulf of Alaska, and then west along the Alaska coast (Figure 3-26). Net current velocity is about 0.5 km/hr (14 cm/sec) across the central Gulf of Alaska, and the width of the current averages 400 km. A dead zone along the continental margin separates a less salty, nearshore, coastal flow from the Alaska Coastal Current.

Major subsurface eddies were identified in the northeastern Gulf of Alaska by Reed (1980). The clockwise currents occur in the vicinity of seamounts. An eddy reaching the surface occurs just west of Kayak Island.

Tidal heights are provided in International Marine (2000a). Tides in the Gulf of Alaska and Cook Inlet are mixed semidiurnal. There are two high and two low tides each day, with the heights of consecutive tidal changes varying in amplitude. Tides in Cook Inlet are among the highest in the world, second only to the Bay of Fundy, while those in the Gulf of Alaska are much smaller. Extreme tides at Anchorage, at the north end of Cook Inlet, reach a low of -165 cm and a high of 1,006 cm. Typical tides have a range closer to 800 cm. Tides at Seldovia, near Homer in the lower inlet, range from a low of -174 cm to a high of 674 cm, with a typical range of 550 cm. Tides at Yakutat, on the shoreline of the open Gulf of Alaska, run from a low of -107 cm to a high of 387 cm, with a typical range of about 300 cm.

Tidal currents information is provided in International Marine (2000b). In Cook Inlet, tidal currents can be very strong. At the Forelands, in the northern inlet, tidal currents average 6.5 km/hr on the flooding tide, and over 7 km/hr on the ebb. Tidal currents in central and northern Cook Inlet tend to be higher during the ebb due to the added volume of freshwater input by river discharge. Near the mouth of the inlet off Homer, currents are slower. The averages are closer to 3.8 km/hr on the flood, and 2.9 km/hr on the ebb. In comparison, tidal currents in the Gulf of Alaska tend to be small. They run from nearly nonexistent to a maximum of 3 km/hr off some points. Typically they are closer to the lower end of this range.

Information on waves is primarily from Brower et al. (1980). Waves in Cook Inlet are generated by local winds and currents. They are highly variable over time. They may rise to over 6 m during a tidal cycle, with wind and current moving in the opposite direction, then drop to half that as the tide changes. They are seldom over 3 m in height.

Wave activity in the Gulf of Alaska is dominated by different sea states. Sea states are characterized by their angular shape and steep, unstable faces. They are chaotic in appearance, with nonuniform height and shape. The chaotic nature of the waves is due primarily to the short fetch and interaction with the existing current system, and is accentuated by the typically high winds during storm events. Maximum significant wave heights reported for the Gulf of Alaska are between 8 and 9.5 m in height. These conditions may be found in any month, but typical waves are less than 2.5 m for most of the year, and less than 3.5 m during the winter. Waves above 10 m are seldom, if ever, found in the area. The period of wind wave at the region ranged from 6 to 10 seconds.

Sea ice may be present in Cook Inlet between early December and the end of March. Freshwater streams transport ice into Cook Inlet on rising tides. These ice pans may freeze together during extended cold weather, coating the surface of the inlet with ice. The northern inlet on rare occasions may reach 100-percent ice coverage, and commonly reaches 90-percent coverage. The lower inlet typically has 0- to 30-percent sea-ice coverage during the same time period. Sea ice does not form on the surface of the Gulf of Alaska. The moderating effect of the North Pacific provides the heat to keep the Gulf of Alaska surface unfrozen.

The Norton Basin Planning Area is in the northeast corner of the Bering Sea. The eastern portion of the area, which forms Norton Sound, is very shallow (10-20 m deep). The western portion extends around St. Lawrence Island, and the northern tip extends up to the Bering Straits. The area is usually ice free from mid-April through mid-December (Hood and Calder, 1981). During the winter, the main driving force of surface currents (the wind) is separated from the water by ice, so the currents are slow. Near the Bering Straits, the currents alternate between a net flow to the north or the south. In the western part of the Planning Area, the surface currents flow to the southwest, creating a polynya or ice-free area in the lee of St. Lawrence Island during the winter.

3.2.1.4. Water Quality

The general water quality in offshore marine waters of the Alaskan arctic is pristine. Industrial activity in the region is confined almost exclusively to the Prudhoe Bay area. The offshore marine environment is not affected by the activities in Prudhoe Bay, so there are functionally no direct anthropogenic inputs to the offshore arctic marine environment. The only degradation to marine water quality is due to plankton blooms, a natural process. These blooms occur primarily during the spring and fall, with the most active blooms during the spring as the ice cover melts and sunlight reaches the nutrient-rich surface waters.

Water quality in the nearshore Arctic Ocean may be affected by both anthropogenic and natural sources. The industrial activities in the vicinity of Prudhoe Bay may have localized effects from year-round input of treated sewage and industrial wastes. The increased oxygen demand of these inputs may lower oxygen levels and increase turbidity. Water quality is also affected by natural erosion of organic material along the shorelines during the summer. Wave action melts the permafrost and erodes the surface layer. This surface layer, rich in organics, increases nearshore turbidity during the summer and may depress nearshore dissolved oxygen concentrations during the winter. These effects are generally seen in waters less than 5 m deep. Another source of altered water quality is sea-ice cover. As sea ice forms during the fall, particulates are removed from the water column by ice crystals as they form and are locked into the ice cover. The result is very low-turbidity levels during the winter.

Oxygen levels in concentrations in the Beaufort Sea are typically high. The low water temperatures increase oxygen solubility, and typical concentrations vary from 8 to 11 milliliters per liter (ml/L) of oxygen. Lower levels have been measured in restricted areas, especially during the winter, when the ice cover limits oxygen exchange with the atmosphere and darkness precludes photosynthesis, but respiration continues, driving oxygen concentrations down. Areas with unrestricted circulation or high respiration seldom drop below 6 ml/L of oxygen (USDOI, MMS, 1996c). In areas of restricted circulation or high respiration, further depletions may occur. Oxygen concentrations as low as 2 ml/L have been measured beneath the ice in a basin of the Colville River delta containing overwintering fishes (USDOI, MMS, 1996c). Areas such as this may become anoxic before spring breakup.

Trace metal concentrations in the Chukchi and Beaufort Seas are elevated compared to the eastern portions of the Arctic Ocean. The higher concentrations are thought to come from Bering Sea waters that pass first through the Chukchi Sea and then through the Beaufort Sea after entering the Arctic Ocean through the Bering Strait (Moore, 1981; Yeats, 1988). However, these waters are still considerably lower in trace metal concentrations than the USEPA criteria for the protection of marine life (Boehm et al., 1987; Crecelius et al., 1991; USDOI, MMS, 1996a, c).

Background hydrocarbon concentrations in Beaufort Sea waters appear to be biogenic and on the order of 1 part per billion (ppb) or less. Sediment concentrations are relatively high compared with other undeveloped OCS areas (Steinhauer and Boehm, 1992). The greatest concentrations of hydrocarbons (suggestive of petroleum sources) were found offshore near the Colville and Kuparuk Rivers. Marine sediment concentrations are greater than riverine sediment concentrations and suggest the possibility of marine seeps (USDOI, MMS, 1996a, c). Hydrocarbon concentrations in the Hope Basin and Chukchi Sea are entirely biogenic in origin and are typical of levels found in unpolluted marine waters and sediments (USDOI, MMS, 1996a, c).

Turbidity has a major impact on water quality parameters in Cook Inlet and the Gulf of Alaska. Glacial silt from numerous rivers enters Cook Inlet and the Gulf of Alaska. The glacial silt blocks sunlight from reaching below the water surface, limiting plankton and attached algal production. High turbidity is most evident in the vicinity of major glaciation, such as the Yakutat area, and in Cook Inlet. Levels in the Gulf of Alaska are typically less than 0.5 ppm, while the waters of Cook Inlet may contain over 100 ppm (USDOI, MMS, 1996d).

Another potential source of water quality degradation is treated sanitary sewage and storm drains entering upper Cook Inlet, especially from Anchorage, the northern Kenai Peninsula, and the lower Matanuska Valley. The very high and turbulent tidal currents in the area have been shown to mix these effluents rapidly, and they are, therefore, of little concern in lower Cook Inlet. They are well removed from the Gulf of Alaska and are likely to have no impact there.

Oxygen levels in the surface waters of Cook Inlet range from about 7.6 meters per liter (m/L) to 10 m/L (Kinney et al., 1970). None of the waters in the inlet have been found to be depleted, due to the strong tidal currents in the inlet that mix the entire water column (Kinney et al., 1970).

Oxygen concentrations in the Gulf of Alaska range from as low as 0.3 ml/L up to 6.0 ml/L, near saturation. They are typically about 6.0 ml/L near the surface but drop rapidly with depth to as low as 0.3 ml/L in near-bottom water (Reed and Schumacher, 1986). The surface waters are near saturation, but a combination of minimal deep-water circulation and a high organic load in the deep waters is the cause of the low oxygen values (Reed and Schumacher, 1986).

Point sources for trace metal pollution in Cook Inlet include the Municipality of Anchorage Point Woronzof Wastewater Treatment Facility and the produced waters from offshore petroleum production operations in lower Cook Inlet. Stream discharges into Cook Inlet also include a variety of metals. Zinc discharges from streams probably exceed 89,000 kilograms per year (kg/yr), and 50,000-117,000 kg/yr are discharged from point sources (USDOI, MMS, 1996d). Barium, mercury, and cadmium are also discharged via streams and rivers as well as municipal and industrial sources. Barium is a major component of drilling muds (i.e., barite [barium sulfate] constitutes about 63 percent of drilling muds, and barium is about 59 percent of the barite). Mercury and cadmium are also found in barite and municipal wastewater effluent. Estimated concentrations are 27-38 grams per liter (g/L) of barium, less than 0.1 g/L of mercury, and less than 1 g/L of cadmium (USDOI, MMS, 1996d).

Trace metal concentrations in the northeastern Gulf of Alaska are generally below accepted ocean mean values. Water column concentrations meet USEPA criteria and are considered representative for the rest of the region (USDOI, MMS, 1996a, d).

Hydrocarbons are found throughout the waters of Cook Inlet but are generally low in concentration and of biogenic origin (USDOI, MMS, 1996d). Concentrations are generally similar to those found in other unpolluted coastal areas. Sediment total organic carbon is low and suggestive of an unpolluted environment (USDOI, MMS, 1996d).

Hydrocarbon concentrations in the Gulf of Alaska waters are low and characteristic of unpolluted waters. Many streams between Icy and Katalla Bays that discharge into the Gulf of Alaska drain areas with natural, active oil and gas seeps (Blasko, 1976). Hydrocarbon concentrations at seep sites range from 0.8 to 246,000 mg/L. However, near the mouths of streams, concentrations are generally about 0.1 mg/L.

The water quality in the Norton Basin Planning Area is described in USDOI/MMS (1991) and is summarized here. The general water quality in the Planning Area is pristine, similar to the water quality in the Alaskan arctic. However, the water is turbid in shallow Norton Sound, especially near the outflow from the Yukon River on the south side of the Sound. Mercury and other heavy metals are deposited in the sediments along the northern part of the Sound near the old gold-mining community of Nome. However, ambient concentrations of trace metals in northwestern Norton Sound waters were found to meet USEPA criteria and State standards. Oxygen concentrations were found to be high in northwestern Norton Sound waters, and there was no evidence of petroleum hydrocarbons in the water column of Norton Basin.

3.2.1.5. Acoustic Environment

See section 3.1.1.5 for a general discussion of noise.

3.2.1.5.1. Arctic

Although Norton Basin is not truly in the arctic, climatic and environmental conditions in Norton Basin resemble arctic conditions more closely than subarctic conditions. The waters of the arctic are a unique noise environment mainly due to the presence of ice, which contributes significantly to ambient noise levels. Ambient noise levels in the Beaufort and Chukchi Seas can vary dramatically between seasons and sea-ice conditions. Sea ice significantly contributes to ambient noise levels in the arctic. Temperature changes result in cracking, and ice deformation due to wind and currents produces low frequency noises. In winter and spring, landfast ice produces significant thermal cracking noise (Milne and Ganton, 1964). In areas characterized by a continuous fast-ice cover, the dominating source of ambient noise is the ice cracking induced by thermal stresses (Milne and Ganton, 1964). The spectrum of cracking noise typically displays a broad range from 100 Hz to 1 kHz, and the spectrum level has been observed to vary as much as 15 dB within 24 hours due to the diurnal change of air temperature. Spring noises peaked at 90 dB re 1 μPa^2 /Hz at infrasonic frequencies. Winter noises include wind-induced noise, as well as thermal cracking sounds. Ice deformation can produce noises at frequencies of 4 to 200 Hz (Greene, 1981). As icebergs melt, they produce additional background noise with a spectrum level at approximately 62 dB re 1 μPa^2/Hz at a range of 180 m from the iceberg (Urick, 1971). While sea ice can produce significant amounts of background noise, it can also function to dampen ambient noise. Areas of water with 100 percent sea-ice cover can reduce or completely eliminate noise from waves or surf. The marginal ice zone, the area near the edge of large sheets of ice, is usually characterized by quite high levels of ambient noise compared to other areas. The impact of waves against the ice edge is a major source of ambient noise, but also the breaking up and rafting of ice floes contribute significantly to the ambient noise (Milne and Ganton, 1964).

Marine mammals can contribute significantly to the background noise in the acoustic environment of the Beaufort and Chukchi Seas; however, frequencies and levels depend highly on seasons. For example, in the spring, bearded seals dominate ambient noise at frequencies near 1 kHz; however, their calls are almost absent in other seasons. Bearded seal songs have a source level of about 178 dB re 1 μPa at 1 m. Ringed seal calls have a source level of 95-130 dB re 1 μPa at 1 m, with the dominant frequency under 5 kHz (Richardson et al., 1995). During spring migrations, bowhead whales produce long song notes that cover a broad frequency range and are transmitted many kilometers (Ljungblad et al., 1982; Cummings and Holliday, 1987; Würsig and Clark, 1993). Bowhead whales produce sounds with source levels ranging from 128-189 dB re 1 μPa at 1 m and with a dominant frequency range from 100 to about 4000 Hz (Richardson et al., 1995).

Vessel traffic in the Beaufort and Chukchi Seas is limited to summer, at which time it contributes to the ambient noise level. In shallow water, shipping traffic more than 10 km away from a receiver generally contributes only to background noise (Richardson et al., 1995). However, in deep water, traffic noise up to 4,000 km away may contribute to background noise levels (Richardson et al., 1995). Shipping traffic is most significant at frequencies from 20 to 300 Hz (Richardson et al., 1995). Fishing and whaling boats in coastal regions also contribute sound to the overall ambient noise. Sound produced by these smaller boats is typically at a higher frequency, around 300 Hz (Richardson et al., 1995).

Ice breaking vessels produce some of the strongest sounds associated with oil and gas operations. A typical icebreaking operation involves ramming the ship forward into the ice until momentum is lost, followed by backing astern in preparation for another run at the ice. Such operations result in highly variable levels of radiated noise (particularly propeller cavitation). Even with rapid attenuation of sound in heavy ice conditions, the elevation in noise levels attributed to ice breaking can be substantial out to at least 5 km (Richardson et al., 1991). In some instances, icebreaking sounds are detectable from greater than 50 km away. In general, spectra of icebreaker noise are wide and highly variable over time (Richardson et al., 1995).

Offshore geophysical seismic surveys conducted in the summer are another source of noise in the arctic marine environment. Sounds produced by seismic pulses can be detected by mysticetes and odontocetes that are from 10 to 100 km from the source (Greene and Richardson, 1988; Bowles et al., 1994; Richardson et al., 1995). Air gun arrays are the most common source of seismic survey noise. A typical full-scale array produces a source level of 248 to 255 dB re 1 μPa-m, zero to peak (Barger and Hamblen, 1980; Johnston and Cain, 1981). While the seismic air gun pulses are directed towards the ocean bottom, sound propagates horizontally for several kilometers (Greene and Richardson, 1988; Hall et al., 1994). In waters 25 to 50 m deep, sound produced by airguns can be detected 50 to 75 km away, and these detection ranges can exceed 100 km in deeper water (Richardson et al., 1995). No seismic operations have been conducted in Norton Basin in recent years.

Currently, there are several oil production facilities on artificial islands in the Beaufort Sea. Shepard et al. (2001) characterized noise conditions during construction of the offshore Northstar production facility with and without a vibrahammer operating. Manmade underwater noise (from the vibrahammer or from vehicle and machinery noise) was higher near the bottom compared to measurements taken at mid-water column depth. Noise levels measured 150 m from the island during vibrahammer operations varied from 0 to 50 dB re 1 μPa per Hz per 1/3 octave band with strong tonal frequencies at 23 and 30 Hz. Vehicle and machinery noise 150 m from the island at the 1/3 octave band spanned 2 Hz to 1 kHz, with levels rising as high as 40 dB above ambient conditions. In general, the noise environment approximately 4 km north of Northstar had hardly any apparent manmade noise contamination. Typically, noise propagates poorly from artificial islands, as it must pass through gravel into the water (Richardson et al., 1995). In the ice-covered season, drill noises only propagate 2 to 10 km into the surrounding water. During the open-water season, drilling sounds may be detected slightly further away, but still at low levels.

3.2.1.5.2. Subarctic

As in the Beaufort and Chukchi Seas, ambient noise levels and the acoustic environment in the subarctic region vary greatly among seasons and even daily. As in the arctic, however to a lesser degree, ice plays a role in the ambient noise levels (see previous discussion of ice and noise). In contrast to the arctic environment, strong tidal fluctuations and currents function as additional sources of ambient noise in Cook Inlet. Wind and wave action also contribute to ambient noise. Shipping traffic is more pronounced in Cook Inlet than in the Arctic Ocean. Shipping traffic dominates the spectra of ambient noise between 20 and 300 Hz. Fishing vessels produce high frequency sound peaking at 300 Hz, whereas larger cargo vessels produce more lower frequency sounds (Richardson et al., 1995).

Sounds produced by offshore oil and gas platforms in Cook Inlet have not been well studied. However, drilling platforms and combined drilling/production platforms in California produce little sound that is transmitted into the water (Gales, 1982).

Marine mammals in Cook Inlet also contribute to ambient noise. Gray whales produce knocks and pulses with frequencies from less than 100 Hz to 2 kHz. Humpbacks in southeast Alaska produce sounds between 20 and 2,000 Hz (Thompson et al., 1986). Fin whales typically produce calls around 20 Hz, which can be transmitted up to 185 km (Cummings and Thompson, 1971).

The acoustic environment of the Yakutat area is similar to that of Cook Inlet. The major contributors to ambient noise are shipping traffic, wind and wave action, and marine mammals. Currently, there are no offshore drilling activities in the Yakutat area, and no leasing is proposed in this 5-year program.

3.2.2. Biological Environment

3.2.2.1. Marine Mammals

This section describes the life history attributes, distribution, and seasonal movement of marine mammals of arctic and subarctic Alaska. This discussion focuses on those species that are most likely to be present in coastal habitats bordering the proposed leasing areas, and those important in subsistence harvests. Marine mammals using or thought to use the potentially affected areas are listed in Table 3-19.

Marine mammals are among the most important subsistence resources for Alaskan Natives, and a large body of traditional and local knowledge exists about marine mammals. In recognition of both these factors, many marine mammals are co-managed by the Federal Government (USDOI, FWS or USDOC, NMFS) and Alaskan Native subsistence users, under the authority of the Marine Mammal Protection Act (MMPA) of 1972. Such Native groups include the Alaska Eskimo Whaling Commission (AEWC), the Eskimo Walrus Commission, the Alaska Nanuuq (polar bear) Commission, the Alaska Sea Otter and Steller Sea Lion Commission, and the Alaska Native Harbor Seal Commission. Negotiations are underway to establish co-management with the Alaska Beluga Whale Committee, the Cook Inlet Marine Mammal Council, and the Tribal Government of St. Paul. A number of Alaskan Native organizations regulate the harvest of marine mammals but do not have an agreement with the Federal Government (the Sitka Marine Mammal Council, the Aleut Marine Mammal Commission, and the Pribilof Island Marine Mammal Commission). These organizations represent an enormous potential of stored information and collaborative research. Additional sources of knowledge include a database on Alaskan Native sea lion and seal use compiled by the Alaska Department of Fish and Game (ADFG), and a wealth of testimony on the potential effects of oil and gas activities on marine mammals given at hearings on previous OCS lease sales. This body of information has not been systematically synthesized, but generally supports the descriptive information which follows (and serves as basic data for some of the cited sources). It is somewhat easier to abstract specific pieces of traditional and local knowledge when addressing potential effects (see Chapter 4).

3.2.2.1.1. Threatened and Endangered Species

There are three whale species listed as endangered under the ESA that live or spend a significant portion of their life, in the arctic (the bowhead, fin, and humpback whales). Endangered whale species occurring in the subarctic include humpback, northern right, blue, sei, and sperm whales. The humpback whale is commonly found in both arctic and subarctic waters, although the animals in each region are part of separate humpback stocks. Steller sea lions are also endangered.

Bowhead Whale (*Balaena mysticetus*)

Bowhead whales are distributed in seasonally ice-covered waters of the arctic and near-arctic, typically between 54° N. and 75° N. latitude in the western Arctic Basin (Braham, 1984). The Bering Sea stock (also called the Western Arctic stock) migrates annually from wintering areas (November to March) in the northern Bering Sea through the Chukchi Sea in the spring (March through June) and into the Canadian Beaufort Sea, where they spend much of the summer (mid-May through September). In the fall (September through November), the bowheads return along this general route, closer to shore across the Beaufort Sea, to the Bering Sea to overwinter in polynyas and along edges of the pack ice (Braham et al., 1980a; Moore and Reeves, 1993). Fall surveys show that the bowhead whales are found close inshore east of Barter Island and from Cape Halkett to Point Barrow (Moore and Reeves, 1993) generally in water depths less than 50 m (Treacy 1991, 1994, and 1996). The bowhead spring migration corridor is centered at 71°30' N. (Richardson et al., 1995) and follows fractures in the sea ice around the coast of Alaska, generally in the shear zone between the shorefast ice and the mobile polar pack ice (Ferrero et al., 2000). The spring and fall migration routes of thee bowhead whale are depicted in Figure 3-35.

Ferrero et al. (2000) calculated a minimum population estimate of 7,738 animals for the western arctic stock. A refined and larger sample of acoustic data from 1993 has resulted in an estimate of 8,200 animals (International Whaling Commission [IWC], 1996; Raftery and Zeh, 1998). The IWC estimates a 3.2-percent rate of increase from 1978 to 1993 (IWC, 1996). Eskimos have hunted bowhead whales for at least 2,000 years (Marquette and Bockstoce, 1980; Stoker and Krupnik, 1993). Alaska Native hunters take approximately 0.1-0.5 percent of the population annually (Philo et al., 1993), taking 14 to 72 whales per year for subsistence purposes (Stoker and Krupnik, 1993). The AEWC was the first and is still perhaps the most successful example of Native co-management (in effect, almost full management) of a wildlife species. The AEWC won such respect, at least in part, through their marshalling of traditional and local knowledge with a rigorous study design to establish that bowhead whale populations were actually higher than non-Native whale scientists had previously believed (Albert, 2000; George and Albert, 1999).

No critical habitat for bowheads has yet been defined. However, NMFS is currently reviewing a petition to designate critical habitat. Bowheads are most sensitive during their spring migration when calves are present and their movements are restricted to open leads in the ice. Mating in bowhead whales occurs mostly during late winter or early spring (Nerini et al., 1983; Koski et al., 1993). Calving peaks in May during the spring migration, although the calving season may in some years extend from late March to early August (Nerini et al., 1983). Bowheads are thought to feed throughout the water column (Würsig et al., 1984) and during both spring and fall migrations (more so in the fall). Feeding concentrations occur in areas east of Barter Island (Thomson and Richardson, 1987) and, in some years, near Point Barrow (Braham et al., 1984; Ljungblad et al., 1984; Carroll and George, 1985; George et al., 1987). Preliminary data from a recent study by Lowry and Sheffield (in preparation) present information on the feeding status of five animals taken near Cross Island during 1987-2000. While there is an indication from the draft report that some of the whales were considered to have been feeding, the analysis is not complete, and conclusions cannot be drawn about feeding at Cross Island. Food items of bowheads include euphausiids, mysids, copepods, and amphipods (Lowry and Frost, 1984).

Fin Whale (*Balaenoptera physalus*)

Fin whales range from subtropical to arctic waters and are usually found in high-relief areas where productivity is probably high (Brueggeman et al., 1988). Their summer distribution extends from central California into the Chukchi Sea, while their winter range is restricted to the waters off the coast of California. In Alaskan waters, some fin whales feed in the Gulf of Alaska, while others migrate farther north to feed throughout the Bering and Chukchi Seas from June through October. From September through November, most migrate southward to California; however, a few animals may remain in the Navarin Basin (Brueggman et al., 1984). Northward migration begins in spring with migrating whales entering the Gulf of Alaska from early April to June (USDOI, MMS, 1996d). The North Pacific fin whale population was estimated at 16,600 individuals in 1991 (USDOI, MMS, 1996d). Reliable current abundance estimates are not available, and there is no indication that the stock is recovering to pre-whaling population levels (Braham, 1992; Ferrero et al., 2000).

Fin whales usually breed and calve in the warmer waters of their winter range. Breeding can occur year-round, but the peak occurs between November and February (Tomilin, 1957; Ohsumi, 1958).

Fin whales are opportunistic feeders, taking euphausiids, copepods, fishes, and squids (Lowry et al., 1982).

Humpback Whale (*Megaptera novaeangliae*)

Two stocks of humpback whales occur in Alaskan waters: the western North Pacific stock (approximately 394 individuals; Calambokidis et al., 1997) and the central North Pacific Stock (approximately 3,698 individuals; Ferrero et al., 2000). Recent estimates indicate that the central North Pacific stock is increasing in abundance (Ferrero et al., 2000).

The western North Pacific stock spends winter and spring in waters off Japan and migrates to the Bering Sea, Chukchi Sea, and Aleutian Islands in the summer and fall (Berzin and Rovnin, 1966; Nishiwaki, 1966; Darling, 1991). During migrations, humpbacks are pelagic. The central North Pacific stock winters in Hawaiian Island waters and migrates to northern British Columbia/southeast Alaska and Prince William Sound west to Kodiak Island in the summer and fall (Baker et al., 1990; Perry et al., 1990; Calambokidis et al., 1997). In the Gulf of Alaska, concentration areas of humpbacks include the Portlock and Albatross Banks and west to the eastern Aleutian Islands, Prince William Sound, and the inland waters of southeast Alaska (Berzin and Rovnin, 1966).

Breeding and calving occur on the wintering grounds, and most births occur between January and March (Johnson and Wolman, 1984). Humpback whales are thought to feed mainly during the summer (Wolman, 1978). During summer feeding periods, humpbacks are generally nearshore. The central North Pacific stock of humpback whale feeding aggregations occurs along the northern Pacific rim. Humpback whale distribution in summer is continuous from British Columbia to the Russian Far East, with humpbacks present offshore in the Gulf of Alaska (Brueggeman et al., 1989; Forney and Brownell, 1996). Their diet consists of euphausiids, amphipods, mysids, and small schooling forage fishes (Tomilin, 1957; Wolman, 1978; Wing and Krieger, 1983). Feeding grounds are critical to the humpback's survival, and they would be most sensitive to oil or gas development or related oil spills in these areas during the summer months.

Northern Right Whale (*Eubalaena glacialis*)

Whaling records indicate that northern right whales in the North Pacific range across the entire North Pacific, north of 35° N. latitude. Commercial whalers hunted right whales nearly to extinction during the 1800's. Wada (1973) estimated a total population of 100 to 200 individuals in the North Pacific. Rice (pers. commun., National Marine Mammal Laboratory Seattle, WA, 1974) observed that, with only a few individuals remaining in the eastern North Pacific stock and no confirmed sightings of a cow-calf pair since 1900, for all practical purposes the northern right whale was extinct. However, several notable sightings of right whales in the North Pacific recently occurred. A group of 3-4 right whales was sighted in the western Bristol Bay, southeastern Bering Sea (July 30, 1996), which apparently included a juvenile animal (Goddard and Rugh, 1998). In July 1997, 1998, and 1999, a few individuals were encountered in the general area of Bristol Bay and the southeastern Bering Sea (C. Tynan, pers. commun., National Marine Mammal Laboratory, Seattle, WA,1999; W. Perryman, pers. commun., Southwest Fisheries Science Center, La Jolla, CA, 1999). A reliable current estimate of the abundance for the North Pacific right whale stock is not available. Migratory patterns of the North Pacific stock are unknown. The whales in the North Pacific population may summer in high-latitude feeding grounds and migrate to more temperate waters during the winter (Braham and Rice, 1984). Right whales calve in coastal waters during the winter (Scarff, 1986). However, no calving grounds have ever been found in the eastern North Pacific. Right whales feed primarily on calanoid copepods, and secondarily on euphausiids (USDOI, MMS, 1996d).

Blue Whale (*Balaenoptera musculus*)

The range of blue whales is known to encompass much of the North Pacific Ocean. In Alaska, blue whales are known to occur in a narrow area just south of the Aleutian Islands between 160° W. and 175° W. longitude (Berzin and Rovnin, 1966; Rice, 1974). They can also be found north of 50° N. latitude extending from southeastern Kodiak Island across the Gulf of Alaska and from southeast Alaska to Vancouver Island (Berzin and Rovnin, 1966). Recent work based on the presence of rare epizoites on blue whales, not found on other species known to migrate north, suggests that the Gulf of Alaska and eastern Aleutians population is separate from the California population (Rice, 1992). This view is supported by the work of Calambokidis et al. (1995) and Gilpatrick et al. (1996). The agreement between abundance estimates calculated from line-transect surveys off California (Barlow, 1995) and from sight-resight (photo-identification) data from California (Calambokidis and Steiger, 1995) adds further support to the Alaska stock hypothesis. Recent surveys have failed to sight blue whale feeding aggregations in Alaskan waters (Ferrero et al., 2000). There is relatively little information on the abundance or mortality of blue whales since hunting ceased in 1967. The most recent estimate of the entire North Pacific blue whale population is approximately 1,600 individuals (Mizroch et al., 1984). There is no evidence that the blue whale population is recovering (Mizroch et al., 1984; USDOI, MMS, 1996d).

Blue whales usually begin migrating south out of the Gulf of Alaska by September (Berzin and Rovnin, 1966). The North Pacific blue whale population winters from the open waters of the mid-temperate Pacific south to at least 20° N. latitude (USDOI, MMS, 1996d). Migration routes are thought to be along the western coast of North America. The northward spring migration begins in April or May, with whales traveling along the American shore of the Pacific (Berzin and Rovnin, 1966). Mating and calving take place over a 5-month period during the winter (Mizroch et al., 1984). Feeding takes place in pelagic and coastal waters. On their summer range, the principal food source of blue whales is small euphausiid crustaceans (Nemoto, 1959; Berzin and Rovnin, 1966).

Sei Whale (*Balaenoptera borealis*)

Sei whales are most common in temperate pelagic waters and only occasionally venture into the Bering Sea. They apparently migrate to lower latitudes in the winter and to higher latitudes in summer. Their distribution tends to be far out to sea in temperate regions of the world, and they do not appear to be associated with coastal features. Sei whales have been reported in the Gulf of Alaska and along the Aleutian Islands during the summer (Wada, 1981), with the highest number of sightings south of the Aleutian Islands off the eastern Kamchatka Peninsula to the Commander Islands (Nasu, 1963). Their southward migration begins in August or September. There are no abundance estimates or minimum population estimates for sei whales along the U.S. West Coast or in the eastern North Pacific. The most current estimate of the population of North Pacific sei whales is 9,100 individuals (Tillman, 1977).

Sei whales breed and calve in the warmer waters of their winter range. Most breeding occurs from October to March, peaking in December. Calves are born from September to February with a peak in November (Masaki, 1976). Kawamura (1980) found that copepods comprised 83 percent of the diet, euphausiids 13 percent, fishes 3 percent, and squids 1 percent.

Sperm Whale (*Physeter macrocephalus*)

Sperm whales are distributed widely in the North Pacific, with the northernmost boundary extending from Cape Navarin (62° N. latitude) to the Pribilof Islands (Omura, 1955). The shallow continental shelf is thought to prevent their movement into the northeastern Bering Sea and Arctic Ocean (Rice, 1989). Females and young sperm whales usually remain in tropical and temperate waters year-round (Gosho et al., 1984). Males are thought to move north in the spring (March through May) and summer to feed in the Gulf of Alaska, Bering Sea, and waters around the Aleutian Islands (Berzin and Rovnin, 1966). Fall migrations begin in September, and most whales have left Alaskan waters by December (USDOI, MMS, 1996d), returning to temperate and tropical portions of their range, typically south of 40° N. latitude in the fall (Gosho et al., 1984; Ferrero et al., 2000).

Current and historic abundance estimates for sperm whales in the North Pacific are considered unreliable (Ferrero et al., 2000). Kato and Miyashita (1998) estimate 102,112 sperm whales in the western North Pacific, but suggest their estimate is upwardly biased. Barlow and Taylor (1998) estimated 39,200 sperm whales in the eastern temperate North Pacific. The number of sperm whales occurring in Alaskan waters is unknown (Ferrero et al., 2000).

Breeding occurs during the spring and early summer (April through August). Sperm whales feed primarily on medium- to large-sized squids, but also feed on large demersal and mesopelagic fishes, sharks, and skates (Gosho et al., 1984)

Steller Sea Lion (*Eumetopias jubatus*)

Steller sea lions range along the North Pacific Rim from northern Japan to California (Loughlin et al., 1984). The centers of abundance and distribution are located in the Gulf of Alaska and the Aleutian Islands. At sea, Steller sea lions commonly occur near the 200-m depth contour, but have been seen from nearshore to well beyond the continental shelf (Kajimura and Loughlin, 1988).

Aerial and ground-based surveys suggest a minimum abundance of 39,031 Steller sea lions in the western U.S. stock (west of Cape Suckling, Alaska) in 1998 (Sease and Loughlin, 1999). The first reported trend counts of Steller sea lions in Alaska indicated at least 140,000 sea lions in the Gulf of Alaska and Aleutian Islands (Kenyon and Rice, 1961; Mathisen and Lopp, 1963). Counts in 1976 and 1979 estimated 110,000 sea lions and suggested a major population decrease in the Aleutian Islands beginning in the mid-1970's (Braham et al., 1980b). The largest declines occurred in the eastern Aleutian Islands and western Gulf of Alaska, but declines have also occurred in the central Gulf of Alaska and the central Aleutian Islands. The cause of the population decrease is uncertain. Hypotheses are that available prey sources have decreased in abundance or there has been a significant change in prey species composition. Commercial fisheries may be a factor affecting prey availability. Counts at trend sites from 1990 to 1996 indicate a 27-percent decline. Counts at trend sites in 1998 suggest a further 7.8-percent decline since 1996 (Ferrero et al., 2000).

The 1994 estimate of the eastern U.S. stock (east of Cape Suckling, Alaska) of Steller sea lions in southeast Alaska is 14,571 (Sease et al., 1999). This is a transboundary stock that includes sea lions from British Columbia rookeries. The eastern U.S. stock is thought to have increased since 1994 in British Columbia and to have remained relatively stable in southeast Alaska and in California and Oregon (USDOC, NMFS, 1995; Sease et al., 1999).

Steller sea lions use specific locations along the coast of Alaska as rookeries and haulout sites (Figure 3-27). About three fourths of all Steller sea lions haul out and pup in U. S. territory (Marine Mammal Commission, 2000). All sea lion haulout sites are considered critical habitat because of their limited numbers and high-density use. Alteration of these areas through disturbance or habitat destruction could have a significant impact on the use of these sites by sea lions. Protection measures that are currently in effect limit activities that may reduce prey availability and disturbance of sea lions. Sea lion rookeries in Alaska are located in the Pribilof Islands, on Amak Island north of the Alaska Peninsula, throughout the Aleutian Islands and western Gulf of Alaska to Prince William Sound, and on Forrester Island, White Sisters, and Hazy Island in southeast Alaska. Haulouts are numerous throughout the breeding range.

Special foraging areas in Alaska have also been designated critical habitat for stellar sea lions. They include the Shelikof Strait area of the Gulf of Alaska, the Bogoslof area in the Bering Sea shelf, and the Seguam Pass area in the central Aleutian Islands. Steller sea lions eat a variety of fishes and invertebrates. Harbor seals, spotted seals, bearded seals, ringed seals, fur seals, California sea lions, and sea otters also are occasionally eaten (Tikhomirov, 1959; Gentry and Johnson, 1981; Pitcher, 1981; Pitcher and Fay, 1982; Byrnes and Hood, 1994). Walleye pollock is the principal prey in most areas of the Gulf of Alaska and the Bering Sea (USDOC, NMFS, 1995). In the Aleutian Islands, Atka mackerel was the most common prey, followed by walleye pollock and Pacific salmon (USDOC, NMFS, 1995).

While Steller sea lions have been an important subsistence resource of Alaska Natives in the past, their harvest has declined greatly. This corresponds with the period of time when the Steller sea lion population was itself declining greatly in southwest Alaska. The relationship between the two is not clear, but the two dynamics may well be related. Because of the endangered status of the southwest Alaska Steller sea lion population, the Bering Sea and Gulf of Alaska groundfish fisheries have been restricted from fishing in critical sea lion habitat, on the presumption that the fishery may interfere with sea lion feeding (Amerongen, 2000; Continental Shelf Associates, Inc. and LGL Alaska Research Associates, Inc., 2001). Many local residents have stated their belief in this relationship, based on traditional and local knowledge gained through their own and relatives' observations and life experiences (ADFG, 1998).

3.2.2.1.2. Nonendangered Species

Several species of marine mammals that are not listed as endangered or threatened occur in Alaska's arctic and/or subarctic waters. Cetaceans, pinnipeds, and carnivores are discussed in separate sections.

Cetaceans

There are six species of nonendangered cetaceans that are present seasonally or year-round in the OCS planning areas in Alaskan waters: beluga whales, gray whales, minke whales, killer whales, harbor porpoises, and Dall's porpoises. A project is currently underway to make traditional and local knowledge of Beaufort Sea beluga whales more available (Huntington and Mymrin, 2000).

Four of the five Alaska stocks of **beluga whales** (*Delphinapterus leucas*) are found in the proposed OCS lease areas: the Beaufort Sea stock (estimated at 39,258), the eastern Chukchi Sea stock (estimated at 3,710), the eastern Bering Sea stock (estimated at 7,986), and the Cook Inlet stock (estimated at 357) (Ferrero et al., 2000). The stock designation, in part, is based on the whales' summer distribution. During winter, beluga whales occur in offshore waters associated with pack ice. Most belugas overwinter in the Bering Sea, with the exception of the Cook Inlet stock that winters in the northern Gulf of Alaska and Cook Inlet. In the spring, belugas migrate to warmer coastal estuaries, bays, and rivers for molting (Finley, 1982) and calving (Sergeant and Brodie, 1969). Calving is known to occur in the summer in Norton Bay. Most belugas migrate through the Norton Basin in spring. Beluga whales typically migrate into the Beaufort Sea in April or May. Some, however, summer in nearshore shallow waters around Norton Sound. Fall migration through the western Beaufort Sea is in September or October. Most belugas are thought to migrate far offshore along the pack-ice front in the fall (Frost et al., 1988; Richard et al., 1997). In December, belugas return through the northern Bering Sea. The Cook Inlet stock of beluga whales is concentrated in the upper reaches of Cook Inlet in the mid-summer months. Their distribution becomes more dispersed as winter approaches. An aerial survey conducted in Cook Inlet from February 12 through March 14, 1997, sighted 160 individual beluga whales. Of these sightings, 150 were recorded in the middle portion of Cook Inlet, from the west side of Kalgin Island to just north of the East Foreland, and 10 were recorded near the Hubbard Glacier in Yakutat Bay (Hansen and Hubbard, 1999). The Beaufort Sea stock is considered to be stable or increasing in population size (DeMaster, 1995). There is no evidence that the eastern Chukchi Sea or eastern Bering Sea stocks are declining. The Cook Inlet stock of beluga whales was listed as depleted under MMPA on May 31, 2000, due to a severe population decline since 1994 (65 FR 105; 50 CFR 216.15). Annual aerial surveys conducted by NMFS indicated that both the distribution and abundance of the Cook Inlet beluga stock were declining (by nearly 50%) between 1994 and 1999, while reported harvests by Native Alaskan hunters increased. Since the Native Alaskan hunt for belugas ceased in 1998, the stock appears to have stopped declining. Therefore, in June of 2000, NMFS determined that this stock would not be listed under the ESA (65 FR 38778.) It is premature to attribute the most recent abundance increase to an increasing population trend.

The eastern North Pacific stock of **gray whales** (*Eschrichtius robustus*) spends the summer feeding in the northern Bering (Cherikov Basin located west and north of the Norton Basin), Chukchi, and Beaufort Seas (Rice and Wolman, 1971). They have also been reported feeding in waters off of southeast Alaska, British Columbia, Oregon, and Washington during summer. Gray whales migrate near shore along the coast of North America from Alaska to the central California coast beginning in October or November (Rice and Wolman, 1971). They winter primarily along the west coast of Baja California, where pregnant females assemble in particular shallow, nearly landlocked lagoons to calve from January to mid-February (Rice et al., 1981). The northward migration begins in mid-February and continues through May, with cows and newborn calves typically migrating north between March and June (Rice et al., 1981). The most recent abundance estimate for gray whales is 22,571 whales estimated from systematic counts during migration along the central California coast in 1995 and 1996 (Hobbs et al., 1996). The size of the eastern North Pacific gray whale stock has been increasing for several decades (Ferrero et al., 2000). The stock is not considered a strategic stock and was removed from the endangered species list in 1994.

Minke whales (*Balaenoptera acutorostrata*) occur in the North Pacific from the Bering and Chukchi Seas south to near the equator (Leatherwood et al., 1982.). In Alaska, they are considered a distinct stock and are relatively common in the Bering and Chukchi Seas and in the inshore waters of the Gulf of Alaska (Mizroch, 1992); they are not abundant in any other part of the eastern Pacific (Bruggeman et al., 1990). Minke whales are frequently observed near St. Lawrence Island (Norton Basin) from spring through fall. No estimates of the number of minke whales in the north Pacific or within Alaskan waters have been made, nor are there data on trends in the minke whale population in Alaskan waters (Ferrero et al., 2000). Minke whales breed in temperate or subtropical waters throughout the year (Dohl et al., 1981). Peaks of breeding activity occur in January and in June (Leatherwood et al., 1982). Calving occurs in winter and spring (Stewart and Leatherwood, 1985). Minke whales in the North Pacific prey mostly on euphausiids and copepods, but also feed on schooling fishes, including Pacific sand lance and northern anchovy, and squid (Leatherwood et al., 1982; Stewart and Leatherwood, 1985; Horwood, 1990).

"Resident," "transient," and "offshore" **killer whales** (*Orcinus orca*) occur along the entire Alaska coast (Dahlheim et al., 1997) from the Chukchi Sea, into the Bering Sea, along the Aleutian Islands, Gulf of Alaska, and into southeast Alaska (Braham and Dahlheim, 1982). Killer whales are frequently observed near St. Lawrence Island (Norton Basin) from spring through fall. The eastern North Pacific Northern Resident stock of killer whales is estimated at 717 individuals (Ferrero et al., 2000). Currently, there are no reliable data concerning the population trend for this stock (Ferrero et al., 2000).

Dall's porpoises (*Phocoenoides dalli*) are widely distributed along the continental shelf (Hall, 1979) as far north as 65^{o} N. latitude (Buckland et al., 1993). The only apparent gaps in their distribution in Alaska waters are in upper Cook Inlet and the shallow eastern flats of the Bering Sea. The current estimate for the Alaska stock of Dall's porpoise is 83,400 (Ferrero et al., 2000).

Harbor porpoises (*Phocoena phocoena*) are distributed in waters along the continental shelf (Read, 1990), being found most frequently in cool waters where prey are aggregated (Watts and Gaskin, 1985; Continental Shelf Associates, Inc. and LGL Alaska Research Associates, Inc., 2001). The range of the harbor porpoise within the eastern North Pacific Ocean is primarily restricted to coastal waters and extends from Point Barrow, along the coast of Alaska, and down the west coast of North America to Point Conception, California (Gaskin, 1984). Recent population estimates are 29,744 harbor porpoises in Alaskan waters (Ferrero et al., 2000). The major predators on harbor porpoises are white sharks and killer whales (Read, 1990). Unlike other delphinids, harbor porpoises forage independently (Würsig, 1986), feeding on small, schooling fishes typically ranging from 10 to 30 cm in length (Read, 1990).

Pinnipeds

There are seven species of nonendangered pinnipeds found throughout the OCS lease areas in Alaska waters: Pacific walrus, ringed seal, bearded seal, ribbon seal, spotted seal, northern fur seal, and harbor seal.

Pacific walruses (*Odobenus rosmarus divergens*) occur primarily in the shelf waters of the Bering and Chukchi Seas (Allen, 1880; Smirnov, 1929), but occasionally move into the eastern Siberian Sea and western Beaufort Sea during summer (Fay, 1982). The most current minimum population estimate is 188,316 individuals (USDOI, FWS, 1998). In winter, there are two main concentrations located almost exclusively in the Bering Sea. The first occurs in the northwestern Bering Sea, south and west of St. Lawrence Island and in Anadyr Gulf, while the second is located in the southeastern Bering Sea, particularly in Bristol and Kuskokwim Bays (Fay, 1982; Fay et al., 1984). Migration northward to summer range begins in late March or April, coincident with the spring breakup and melting of pack ice. About 90 percent of the Pacific walrus population occurs seasonally within the Norton Basin in relation to the advance and retreat of the pack-ice front during spring and fall migrations. Walruses from the northwestern Bering Sea migrate through Anadyr Strait, between St. Lawrence Island and the Chukotski Peninsula, reaching the Bering Strait in mid-May. Walruses from the southeastern Bering Sea migrate east of St. Lawrence Island, and reach the Bering Strait by late May or early June (Sease and Chapman, 1988). Major seasonal-haulout-concentration areas are located on St. Lawrence Island, King Island, the Diomede Islands in the Bering Strait, and Sledge and Besboro Islands within Norton Sound. Calving takes place in the Norton Basin during spring migration. The majority of walruses spend the summer in coastal areas along the southern edge of the Chukchi Sea pack ice, between Long Strait and Wrangel Island to the west and Point Barrow to the east (Sease and Chapman, 1988). Several thousand others remain in the western Bering Strait, the Gulf of Anadyr, Kamchatka, and Bristol Bay (USDOI, FWS, 1993). With the expansion of pack ice in autumn, walruses in the Chukchi Sea migrate southward, and meet up, south of the Bering Strait, with the northward migration of males that summered in the Bering Sea (Fay et al., 1984; Taggart, 1987). Most walruses reach their wintering areas by December or January (Sease and Chapman, 1988). Mating takes place mostly in February, when the walruses are concentrated southwest of St. Lawrence Island and in the Kuskokwim-Bristol Bay area (USDOI, FWS, 1993). Calves are born during the subsequent spring migration north, mostly in May (Fay, 1981, 1982). Walruses feed on benthic invertebrates, to the near exclusion of other food resources (Sease and Chapman, 1988). Other foods include fishes, cephalopods, and occasionally seals (Sease and Chapman, 1988; Continental Shelf Associates, Inc. and LGL Alaska Research Associates, Inc., 2001).

Ringed, bearded, spotted, and ribbon seals are circumpolar in distribution and are all associated with ice for much or all of the year. The general range of all four species extends from the Beaufort Sea to the southeastern Bering Sea. Spotted and ribbon seals are concentrated in the Bering Sea, while bearded and ringed seals generally occupy areas farther north. Floating sea ice within the Norton Basin provides primary breeding and pupping habitat for tens of thousands of bearded, spotted, and ribbon seals during spring migration. Current reliable population estimates for the Alaska stocks of ringed, bearded, spotted, and ribbon seals are not available (Ferrero et al., 2000). However, earlier estimates range from 1 to 1.5 million for ringed seals (Kelly, 1988), while ribbon and spotted seal populations have been estimated at 240,000 (Burns, 1981a) and 335,000-450,000 (Burns, 1973), respectively. The Bering-Chukchi Sea population of bearded seals is estimated at 250,000-300,000 individuals (Popov, 1976; Burns, 1981b).

Ringed seals (*Phoca hispida*) occupy both seasonal and permanent ice year-round. Within the Norton Basin, primary pupping habitat is located on fast ice along the coast of St. Lawrence Island, Norton Sound, and the Yukon River delta. Ringed seals molt between mid-May to mid-July, at which time they are most visible on the ice. Although they are typically considered nonmigratory, ringed seals make long seasonal movements to the pack ice in the summer and in response to prey availability (Frost and Lowry, 1981).

Bearded seals (*Eringnathus barbatus*) occur year-round in the Beaufort and Chukchi Seas (Ognev, 1935; Johnson et al., 1966; Burns, 1981b). Bearded seals usually inhabit shallow waters (i.e., < 150-200 m) and tend to avoid areas of thick continuous landfast ice (Kosygin, 1966; Burns et al., 1981; Burns, 1981b). Many of the seals that winter in the Bering Sea migrate north in April and May to the summer ice edge of the Chukchi Sea (Burns, 1967; Burns, 1981b). Others remain in the open water of the Bering and Chukchi Seas (Burns, 1981b; Nelson, 1981; Smith and Hammill, 1981).

Ribbon seals (*Phoca fasciata*) in Alaskan waters are primarily found in the open sea or on the pack ice and are rarely seen on landfast ice (Kelly, 1988). From late March to early May, ribbon seals inhabit the Bering Sea ice front (Burns, 1970, 1981a; Braham et al., 1984). As the ice recedes in May to mid-July, the seals move farther north in the Bering Sea, where they haul out on the receding ice edge (Burns, 1970, 1981a; Burns et al., 1981). Kelly (1988) suggests that many ribbon seals migrate into the Chukchi Sea for the summer. Mating takes place from late April to early May (Fay, 1974; Burns, 1981a) on the southern ice front (Shustov, 1965; Burns, 1970). Ribbon seals give birth on the ice to a single pup (Burns, 1981a). Seals tend to be 50-250 km offshore during the pupping and nursing periods, moving to within 20-100 km of shore during the molting season (Tikhomirov, 1966), in May to mid-July (Burns, 1970, 1981a).

Spotted seals (*Phoca largha*) primarily inhabit the southern margin of the ice, moving to coastal habitats with the retreat of the sea ice, where they remain until it returns (Burns and Fay, 1972; Fay, 1974; Shaughnessy and Fay, 1977). Winter distribution and migration routes are poorly known, but recent studies indicate migration south along the ice edge from the Chukchi Sea to the Bering Sea

(Lowry et al., 1994). Females whelp one pup per year (Burns and Fay, 1972) between February and May, coinciding with the maximum ice extent and stability (Burns et al., 1981).

Ringed and bearded seals feed seasonally on a wide variety of invertebrate and fish species. Their diets include crabs, clams, shrimps, and arctic cod (Johnson et al., 1966; Kosygin, 1966; Lowry et al., 1981; Smith, 1981). Ribbon seals consume crustaceans, cephalopods, and fishes, primarily pollock (Frost and Lowry, 1980). Adult spotted seals consume fishes, crustaceans, and cephalopods, with fishes comprising 95 percent (by volume) of the diet.

The **northern fur seal** (*Callorhinus ursinus*) ranges from southern California north to the Bering Sea and west to the Okhotsk Sea and Honshu Island, Japan. However, breeding is restricted to only six large islands and several smaller ones. In 1988, the northern fur seal was listed as depleted under the MMPA. The current population estimate for the eastern Pacific stock is 848,539 individuals (Ferrero et al., 2000) and approximately 1.32 million worldwide (Loughlin et al., 1994). During the breeding season, approximately 74 percent of the population is found on the Pribilof Islands, primarily St. Paul and St. George, with the rest of the individuals distributed throughout the North Pacific Ocean (Lander and Kajimura, 1982). After the breeding season (approximately July through November), females, pups, and juveniles migrate south to pelagic feeding grounds in the North Pacific Ocean (Fiscus, 1983). Adult males typically migrate in August, and usually only as far south as the Gulf of Alaska (Kajimura, 1984). In January and February, both sexes concentrate along the continental margins, and some stock mixing occurs. Northern fur seals have a wide range of prey, including approximately 75 species of fishes, cephalopods, and crustaceans (Wada, 1971; Kajimura, 1984; Sinclair et al., 1994).

Harbor seals (*Phoca vitulina richardsi*) range from Baja California, north along the western coasts of the United States, British Columbia, and southeast Alaska, west through the Gulf of Alaska and the Aleutian Islands, and in the Bering Sea north to Cape Newenham and the Pribilof Islands. Ferrero et al. (2000) estimate 35,226 individuals in the southeast Alaska stock, 12,648 individuals in the Bering Sea stock, and 28,917 individuals in the Gulf of Alaska stock. Trend estimates for Sitka, Ketchikan, and Glacier Bay indicate that the southeast stock has been increasing since at least 1983 (Small et al., 1997). In the Gulf of Alaska, populations declined from the 1970's to the early 1990's; but they have grown since the early 1990's around Kodiak and Tugidak Islands (Small, 1996; Withrow and Loughlin, 1997). However, overall the stock numbers are in decline (Ferrero et al., 2000).

Harbor seals inhabit estuarine and coastal waters, hauling out on rocks, reefs, beaches, and glacial ice flows. They are generally nonmigratory, but move locally with the tides, weather, season, food availability, and reproduction opportunities (Scheffer and Slipp, 1944; Fisher, 1952; Bigg, 1969, 1981). Female harbor seals give birth to a single pup while hauled out on shore or on glacial ice flows. The mother and pup remain together until weaning occurs at 3 to 6 weeks (Bishop, 1967; Bigg, 1969). Little is known about breeding behavior in harbor seals. When molting, seals spend the majority of the time hauled out on shore, glacial ice, or other substrate. Harbor seals consume a wide variety of prey in estuarine and marine waters, such as gadids, clupeids, pleuronectids, salmonids, cephalopods, and crustaceans.

Fissipeds

The distribution of **polar bears** (*Ursus martimus*) is circumpolar in the northern hemisphere, where they inhabit ice-covered seas. In Alaska, they have occurred as far south as St. Matthew Island and the Pribilof Islands (Ray, 1971), extending north and eastward into the Chukchi and Beaufort Seas, from the Bering Strait to the Canadian border. The current minimum population estimate for the Southern Beaufort Sea stock is 1,765 polar bears (USDOI, FWS, 1998a). There is no reliable population estimate for the Chukchi/Bering Sea stock (USDOI, FWS, 1998b); however, a rough estimate places the stock between 1,200 and 3,200 individuals (Amstrup, 1995). An estimated 200 to 300 polar bears, or 10 percent of the western arctic (Chukchi Sea) population, seasonally occur in the western and northern Norton Basin Planning Area (Fig. 2-5), primarily north from St. Lawrence Island. The USDOI, FWS (1998b) suggested that bear densities off of the Alaskan coast have slowly increased since the 1970's. Seasonal movements of polar bears reflect changing ice conditions and breeding behavior. In winter and spring, polar bears are frequently found on three types of ice: shorefast ice with deep snow drifts along pressure ridges, the floe edge, and areas of moving ice with seven-eighths or more ice cover (Stirling et al., 1981). Mature males range far offshore in early spring, moving closer to shore with the spring breeding season. With the breakup of the ice during spring and early summer, polar bears move northward where they inhabit drifting pack ice throughout the summer. With ice formation in the fall, the bears move southward, and by late fall are distributed seaward of the Chukchi and Beaufort Sea coasts.

Females excavate dens in snow on drifting pack ice and land (Lentfer and Hensel, 1980; Amstrup and Gardner, 1994), entering them by late November, with young being born in late December or early January (Harington, 1968). Den emergence occurs between late March and early April. Throughout most of the arctic, polar bears remain with their mothers for approximately 2.5 years.

The predominant prey item of polar bears in Alaska is ringed seals, and to a lesser degree bearded seals (Stirling and McEwan, 1975; Stirling and Archibald, 1977; Stirling and Latour, 1978) and spotted seals. Additionally, bears may take walruses (Kiliaan and Stirling, 1978), beluga whales (Freeman, 1973; Heyland and Hay, 1976; Lowry et al., 1987), and other polar bears, although less frequently (Lunn and Stenhouse, 1985; Taylor et al., 1986). Polar bears also scavenge whale and walrus carcasses (USDOI, FWS, 1993). When regular prey items are not available, polar bears may consume small mammals, birds, eggs, and vegetation, although these foods are not important dietary components (USDOI, FWS, 1993).

Relatively few Alaskan Natives purposely hunt polar bear, as they are not a standard food item and their parts cannot be sold unless made into craft items. Through the International Polar Bear Treaty and the Native Polar Bear Commissions for America and Russia, a quota has been established for polar bear. The quota is managed by the Native co-managers. Polar bear fur is used for some Native clothing, but other fur can be used in its place, and overall demand is not high. Polar bears are among the most avidly observed animals by North Slope Inupiat, and are actors in a great many Inupiat stories. Inupiat respect the polar bear as another great hunter.

Sea otters (*Enhydra lutris*) occur in the coastal waters of the North Pacific Ocean and the southern Bering Sea. Typically, sea otters inhabit nearshore waters less than 35 m deep with sandy or rocky bottoms that support abundant populations of benthic invertebrates (Rotterman and Simon-Jackson, 1988). Canopy-forming kelp beds are used for resting and foraging, although sea otters may also use areas without these beds. While mating can occur at any time of year, most pups are born in late spring. Some estimate that 90 percent of the world sea otter population is located in coastal Alaskan waters (Rotterman and Simon-Jackson, 1988). Surveys conducted by the USDOI, FWS, and USGS in 2000, show a 70-percent decline in the Aleutian Island population over the last 8 years. The 2000 survey indicates that as few as 6,000 otters remain in the Aleutians. In November 2000, the USDOI, FWS designated the northern sea otter (*Enhydra lutris kenyoni*) found in the Aleutian Islands as a candidate species for listing under the ESA (65FR 67343). Sea otters consume an array of sessile and slow-moving benthic invertebrates, including sea urchins, clams, mussels and crabs, octopus, squids, and epibenthic fishes (Rotterman and Simon-Jackson, 1988).

3.2.2.2. Terrestrial Mammals

This section describes the life history attributes, distribution, and seasonal movement of terrestrial mammals of arctic and subarctic Alaska. Focus of this discussion is on those terrestrial species that are most likely to be present in coastal habitats bordering the proposed leasing areas, and those important in subsistence harvests, though numerous other terrestrial mammals may be present in coastal habitats at any given time. Terrestrial mammals using or thought to use the potentially affected coastal areas are listed in Table 3-20.

Terrestrial mammals are also important subsistence resources for both Native and non-Native Alaskans. As such, a great deal of traditional and local knowledge exist among the resident populations Some special management agreements exist for transnational populations such as the Porcupine Caribou Herd (PCH) under a co-management agreement with Federal and State of Alaska agencies. Management of all fish and wildlife is the responsibility of the State of Alaska except where specifically reassigned by Congress (e.g., MMPA, ESA, and Eagle Protection Act). Under a Federal court decision, the USDOI and the U.S. Department of Agriculture are responsible for assuring a Federal subsistence priority on Federal lands and waters. The State regulates harvest with a preference for subsistence use on all lands. The USDOI Federal Subsistence Board acts to regulate the subsistence priority on Federal lands under the Alaskan National Interest Lands Conservation Act (ANILCA), rather than the MMPA. Alaska Natives are heavily represented on the 10 regional advisory subsistence councils that advise the Board. The State's local advisory committees and the regional advisory subsistence council meetings generate a great deal of local knowledge applicable to wildlife management issues. This information is remarkably consistent with that generated by onshore and OCS Federal lease-sale hearings.

3.2.2.2.1. Caribou (*Rangifer tarandus*)

Four caribou herds use habitat adjacent to the Beaufort Sea, Chukchi Sea, and Hope Basin Planning Areas (Figure 3-28). The Western Arctic Herd (WAH) extends from the Chukchi Sea to the Colville River and from the Kobuk River north to the Beaufort Sea. The most recent WAH population estimate was 463,000 (Murphy and Lawhead, 2000). The WAH caribou are important to subsistence hunters, and approximately 20,000 WAH caribou are taken annually, with nonsubsistence harvest removing another 1,000 - 3,000 animals each year (Bente, 1997; Dau, 1997).

The WAH caribou calve in the upper drainage area of the Utukok River in the northwestern foothills of the Brooks range, and along the inner arctic coastal plain (Davis et al., 1982; Murphy and Lawhead, 2000). Postcalving, the WAH moves south and west through the Lisburne Hills and then eastward through the De Long Mountains and the Brooks Range (Davis et al., 1982). In August, the WAH disperses over the entire coastal plain and the northern foothills of the Brooks Range, from the coast eastward to the Anaktuvuk and Colville Rivers (Davis et al., 1982). Wintering areas include the Selawik-Buckland area, the arctic coastal plain, and the central Brooks Range (Davis et al., 1982).

The Central Arctic Herd (CAH) ranges primarily from the Colville River to the Staines and Canning Rivers (Murphy and Lawhead, 2000). The most recent CAH population estimate is 19,700 animals (ADFG, unpublished data cited in Murphy and Lawhead, 2000). Subsistence hunting removes 200-600 CAH caribou annually (Woolington, 1995). The CAH calving is concentrated within 48 km of the coast near the Kuparuk and Milne Point oil fields, and south of Bullen Point (Whitten and Cameron, 1985; Lawhead and Cameron, 1988). Winter habitat is in the northern foothills of the Brooks Range (Woolington, 1997).

The Teshekpuk Lake Herd (TLH) ranges across the arctic coastal plain from Wainwright to Nuiqsut (Carroll, 1992). The current TLH population estimate is 25,000 animals (Bente, 1997). Annual subsistence harvests range from 800 to 2,500 caribou with little sport harvest (Carroll, 1995a). The TLH summer range generally extends from Teshekpuk Lake, where the principal calving grounds are located (Philo et al., 1993), across the coastal plain west of the Colville River delta (Carroll, 1995a). Wintering areas include the Seward Peninsula, the Barrow-Wainwright-Atqasuk area, and the Anaktuvuk Pass area (Philo et al., 1993).

The PCH ranges from the Canning River in Alaska, east through the Yukon and Northwest Territories. In 1995, the PCH population was estimated at 160,000 (Whitten, 1995). The PCH is important in subsistence harvest for 13 communities of Gwich'n, Inupiat, and Inuvialuit. The PCH calves along the Beaufort Sea coast from the Canning River to the Babbage River, south to the Brooks Range. The PCH calving concentrations occur near Camden Bay and the Sadlerochit Mountains between the Canning and Sadlerochit Rivers (USDOI, MMS, 1996a). The PCH winter ranges are in the boreal forests of Alaska and the Yukon Territory (Whitten, 1995). Thomas Napageak indicates that caribou belonging to the PCH come as far west as Nuiqsut only if a southwesterly wind has been blowing steadily for a week and it has been warm, otherwise they will stop at the Sagavanirktok River. He also stated that some mixing occurs between the WAH, CAH, and PCH prior to their moving inland (Nuiqsut Whaling Captains Meeting, 13 August 1996).

Migration of pregnant female caribou north towards the calving grounds begins in April and May (Cameron and Whitten, 1979). Calving begins in late May and peaks during the first 2 weeks of June (Davis et al., 1982; Curtalo and Reges, 1984; Whitten and Cameron, 1985; Lawhead and Cameron, 1988; Fancy et al., 1990). Males arrive on the coastal plain in late June to early July.

Between late June and August, caribou form large aggregations and migrate to the coast for relief from insects (Curtalo, 1975; Roby, 1978; Helle and Aspi, 1983; Dau, 1986). Coastal habitats provide important insect relief areas due to their lower temperatures and winds that reduce insect activity (Pollard and Noel, 1994). During the fall and winter months, arctic caribou herds move inland to wintering grounds (Murphy and Lawhead, 2000). Breeding occurs during October, with the peak estimated in mid- to late October (Murphy and Lawhead, 2000). From November to April, caribou are distributed throughout their wintering areas (Murphy and Lawhead, 2000).

3.2.2.2.2. Muskox (*Ovibos moschatus*)

Muskoxen were reintroduced to the eastern North Slope in 1969 and 1970 when 51 animals were released on Barter Island and 13 near the Kavik River, respectively (Lenart, 1999). Following their release, muskoxen numbers increased through the 1990's, and at least 700 now occupy the eastern North Slope of Alaska and northwestern Canada (Lenart, 1999). Calving areas are poorly known, but most muskoxen appear to calve in the southern portion of the coastal plain and in upland foothill sites. The rut occurs from August through September, and calves are born from April to June, peaking in mid-May (Reynolds et al., 1986; Reynolds, 1992). In winter, muskoxen form groups of 6-60 individuals, and the herd remains in localized areas. Groups of 5-20 are typical during summer when groups move more frequently (Lenart, 1999).

3.2.2.2.3. Arctic Fox (*Alopex lagopus*)

Arctic fox are found throughout arctic tundra habitats in western and northern Alaska, including the Beaufort and Chukchi Sea areas (Underwood and Mosher, 1982). Arctic foxes typically move between summer breeding areas in coastal tundra and winter habitats along the Alaskan coast (Clough et al., 1987). During fall, winter, and spring, arctic foxes spend much of the ice-covered season out on the sea ice (Chesemore, 1967) and often travel long distances searching for food. In March and April, they move back onshore to mate and den. Fox populations on the North Slope vary annually, depending on food availability and denning sites (Chesemore, 1975). They feed on small mammals, e.g., lemmings, voles, ground squirrels, and birds (Macpherson, 1969). In the summer, they also eat bird eggs. Anthropogenic food sources found in the oil fields have become a major component in arctic foxes' diets (Urquhart, 1973; Eberhardt, 1977; Fine, 1980; Eberhardt et al., 1982; Rodrigues et al., 1994). As a result, high concentrations of arctic foxes are found around construction camps and oil facilities.

3.2.2.2.4. Brown (or Grizzly) Bear (*Ursus arctos*)

Brown or grizzly bears occur in the coastal environments of all three OCS planning areas on the North Slope. The 1994 abundance estimate for brown bears on the North Slope (including coastal plain, foothill, and mountain regions) was 1,553-1,773 animals (Carroll, 1995b; Stephenson, 1995). Brown bears are most numerous on the coastal plain in June and July when caribou congregate in the area. The brown bear population on the arctic coastal plain is currently stable to slightly increasing.

Bears den from early October through late April/May. On the oil fields, bears typically use pingos, stream and river banks, sand dunes, terraces of rivers and streams, low-based mounds, and lake margins for den sites, with pingos being used most frequently (Shideler and Hechtel, 2000). The majority of bears use den sites further inland from the oil fields. Arctic brown bears are opportunistic omnivores, feeding on vegetation, and whenever possible, other animals. Anthropogenic food sources used by bears on the oil fields include garbage from dumpsters and the North Slope landfill, and improperly stored food at work sites (Shideler and Hechtel, 2000).

Brown bears occur throughout the area south of the Alaska Range and in the coastal habitats of the Cook Inlet and Gulf of Alaska Planning Areas. In this region, grizzly populations are stable or increasing, varying between the game management units from several hundred to more than 8,000 individuals. Denning begins in late October, with most bears denned by mid-December. Bears emerge from dens in late March, depending on weather conditions. From mid-April to late July, brown bears are found in grassland areas such as grass flats, sedge meadows, and saltwater bogs (Alyeska Pipeline Service Company, 1995). Brown bears also use upland old-growth forests in spring and early summer, and riparian areas during late summer (Schoen and Beier, 1985). Brown bears in the subarctic region eat a variety of foods including berries, fish, grasses, roots and plants, ground squirrels, and ungulates. Salmon is their main food item from May through August, with both berries and salmon becoming the main dietary items during the fall (September to November).

3.2.2.2.5. Black Bear (*Ursus americanus*)

Black bears are distributed throughout the forests and coastal areas adjacent to the subarctic planning areas. Black bear populations vary across the game management units, ranging from several hundred to several thousand. On the Kenai Peninsula, average dates of den entrance and emergence are October 18 and April 26, respectively, although severe spring weather can delay den emergence (Schwartz et al., 1987). Breeding occurs during the summer. Following den entrance, pregnant females give birth to one to three cubs. Black bears make heavy use of coastal habitats in the Prince William Sound area in the spring following den emergence (Grauvogel, 1967; McIlroy, 1970). During the summer, salmon from spawning runs are common food sources (Frame, 1974).

3.2.2.2.6. River Otter (*Lutra canadensis*)

River otters are distributed throughout areas adjacent to the Cook Inlet and Gulf of Alaska Planning Areas. In Prince William Sound, mean monthly estimates of population density ranged from 36 to 61 and 28 to 45 otters/100 km of coastline, respectively (Faro et al., 1994a). Otters inhabit all types of inland waterways, as well as estuaries and marine coves. Their diet largely consists of fishes, frogs, crayfish, crabs, and other aquatic invertebrates, but birds and land mammals such as rodents and rabbits are also taken (Nowak, 1991). Otters using coastal areas forage in the tidal and subtidal zones for marine fishes and invertebrates (Larsen, 1984; Stenson et al., 1984; Bowyer et al., 1994). In Prince William Sound, otters primarily consume marine, bottom-dwelling fishes; however, marine gastropods, bivalves, and crustaceans also are important components of their diet (Faro et al., 1994a).

3.2.2.2.7. Sitka Black-Tailed Deer (*Odocoileus hemionus sitkensis*)

Sitka black-tailed deer are distributed throughout Game Management Unit 6 along the Gulf of Alaska (Griese, 1989). Their occurrence there is the result of introductions to two islands in Prince William Sound between 1916 and 1923 (Burris and McKnight, 1973; Griese, 1989), from which they spread to other islands and the mainland. The population within Game Management Unit 6 is thought to be stable (Nowlin, 1995), although it has peaked and declined several times since the introduction due to a number of limiting factors (Robards, 1952; Reynolds, 1979); current population estimates for the area are unavailable. The highest densities occur on islands and the lowest on the mainland along Prince William Sound (Nowlin, 1995). Sitka black-tailed deer are also found on the Kodiak Archipelago and along the Gulf of Alaska Planning Area (USDOI, MMS, 1995e).

3.2.2.3. Marine and Coastal Birds

Marine and coastal birds are valued subsistence resources and have been the object of systematic observation for generations. Traditional and local knowledge in this area is less accessible than for marine or terrestrial mammals. Such information may exist but simply may not be as widely shared as for other species, or is known primarily to bird specialists and local experts. However, some oil and gas lease sale hearing testimony and some wildlife management meeting material address birds.

3.2.2.3.1. Threatened or Endangered Species

Threatened or endangered bird species occurring in Alaska that potentially could be affected by offshore oil exploration and production include the spectacled eider, Steller’s eider, and short-tailed albatross. The Aleutian Canada goose was recently delisted but must be monitored for the next 5 years.

Spectacled Eider (*Somateria fischeri*)

Spectacled eiders are listed as threatened under ESA throughout their range in the United States and Russia. The USDOI, FWS has also designated critical habitat (molting areas) for spectacled eider. The critical habitat includes four areas: the Yukon-Kuskokwim delta and adjacent marine waters, Norton Sound, Ledyard Bay, and Bering Sea between St. Lawrence and St. Matthew Islands. As many as 4,000 molting individuals have been observed at one time (Larned et al., 2001)

An estimated 7,029 spectacled eiders (about 2% of the world population) seasonally occupy the arctic coastal plain (Larned et al., 2001) each summer. Spectacled eiders nest in wetland habitats along the arctic coastal plain of Alaska, east to near the Canadian border. Breeding densities decrease from west to east (Larned et al., 1999). Population trends for spectacled eider on the arctic coastal plain are unclear, and survey data may reflect timing of surveys rather than actual densities (Troy Ecological Research Associates, 1997). Spectacled eiders also nest in the Russian arctic and on the Yukon-Kuskokwim delta of Alaska. On the Yukon-Kuskokwim delta, spectacled eider numbers have declined drastically in recent years (Stehn et al., 1993; Ely et al., 1994). Reasons for the decline may be related to subsistence harvest and associated lead poisoning of eider habitats (Franson et al., 1995; Flint and Grand, 1997; Flint et al., 1997), and to predation by arctic fox (Ely et al., 1994).

On the arctic coastal plain, spectacled eiders breed near large, shallow, productive thaw lakes, which often have convoluted shorelines and/or small islands (Larned and Balogh, 1997). Nesting sites are often located within 1 m of a lake shore (Johnson et al., 1996). Ponds with emergent vegetation appear to be important brood-rearing habitat for spectacled eiders (Anderson et al., 1995). Males leave the breeding grounds as incubation begins, usually around mid-June, and begin a molt migration, stopping in bays and lagoons to molt and stage for fall migration. Important molting and staging areas include Harrison Bay, Peard Bay, Kasegaluk Lagoon, Ledyard Bay, and eastern Norton Sound (Johnson et al., 1992; Larned and McCaffery, 1993; Laing and Platte, 1994; Larned et al., 1995; Troy Ecological Research Associates, 1999). Females and young of the year begin to depart the breeding grounds in late June, and the movement continues until the end of August (Troy Ecological Research Associates, 1999). Early departing females may be nonbreeders or may have had failed nesting attempts.

Possibly, the entire spectacled eider population may winter in the central Bering Sea south of St. Lawrence Island (Petersen et al., 1999). Spectacled eiders would not be expected to occur in the subarctic planning areas, other than as possible accidental visitors.

Steller's Eider (*Polysticta stelleri*)

The Alaskan breeding population of Steller's eiders is listed as threatened under the ESA. The USDOI, FWS designated critical habitat for Steller's eiders, which includes nesting areas on the Yukon-Kuskokwim delta and areas on the north side of the Alaska Peninsula (Izembek Lagoon, Nelson Lagoon, and Seal Islands) where Steller's eiders molt, winter, and stage during spring migration.

Historically, Steller's eiders nested along the western arctic coastal plain in Alaska from approximately Point Lay east to the Canadian border (Gabrielson and Lincoln, 1959). The USDOI, FWS (1999) estimated there were about 1,000 individuals in the arctic coastal plain population. Recent breeding population surveys have indicated that small numbers still occur on the arctic coastal plain east to the Meade River (Larned et al., 1999) and south of Harrison Bay (Noel et al., in prep.), with a known concentration in some years near Point Barrow (Quakenbush et al., 1995). Steller's eiders have also been observed occasionally in the Prudhoe Bay area in recent years (Troy Ecological Research Associates, 1997). On the Yukon-Kuskokwim delta, Steller's eider numbers have declined and this species was thought to be extinct as a breeding bird on the Yukon-Kuskokwim delta (Kertell, 1991). Recently, a few pairs have been found breeding on the Yukon-Kuskokwim delta (Flint and Herzog, 1999).

Concentrations of molting Steller's eiders have been observed near Bering Sea islands, and in bays and estuaries from southwest Alaska to the northern shore of the Alaska Peninsula. Kessel (1989) noted that eiders typically move through the Bering Strait between mid-May and early June. Steller's eiders gather in staging areas before beginning their spring migration. Large numbers congregate during spring migration at Izembek Lagoon, Port Moller, Port Heiden, Ugashik Bay, and Kuskokwim shoals (USDOI, FWS, 1999). Steller's eiders winter in shallow, nearshore marine waters along the Alaska Peninsula from the eastern Aleutians to Kodiak Island (USDOI, FWS, 1999). Larned and

Zweifelhofer (2001) surveyed the Akhiok-Moser Bay area of the Kodiak Archipelago in January and February 2001. Small flocks ranging from 1 to 250 individuals were most abundant in lagoons and extensive eelgrass shoals. In this survey, they recorded 4,196 individuals. Extrapolating data from previous surveys, they provided an adjusted estimate of 5,341 Steller's eiders in 2001. Smaller numbers winter in the Gulf of Alaska and from the central Aleutians to the Commander Islands (USDOI, FWS, 1999). Small numbers may also occur in Kachemak Bay. Given the proximity of known wintering areas of Steller's eiders to proposed oil leases in the lower Cook Inlet, they could occur in the subarctic planning areas. The Steller's eider diet includes crustaceans, amphipods, and mollusks (Continental Shelf Associates, Inc. and LGL Alaska Research Associates, Inc., 2001; Peterson, 1981).

Short-tailed Albatross (*Diomedea albatrus*)

Short-tailed albatross is listed as endangered by the USDOI, FWS throughout its range and as an endangered species in the State of Alaska by the ADFG. The decline in the short-tailed albatross population was due to widespread harvest of birds for their feathers, from the breeding grounds in Japan during the late 1800's and early 1900's. The population was estimated at 50 birds in the 1940's but had increased to over 600 birds by 1993.

Short-tailed albatross is a pelagic species that wanders north from western Pacific breeding grounds to the Gulf of Alaska and the Bering Sea. From 1990 to 1998, at least 27 sightings of short-tailed albatross have been reported in the Gulf of Alaska (Alaska Natural Heritage Program, 1998). Short-tailed albatross are surface feeders and frequently sit on the ocean surface. The diet of the short-tailed albatross includes squids, small fishes, and crustaceans. Critical foraging habitat of the short-tailed albatross includes the coastal regions of the North Pacific Ocean and Bering Sea during the nonbreeding season and throughout the northwestern Hawaiian Islands during the breeding season. Short-tailed albatross are rare visitors to the subarctic planning areas.

3.2.2.3.2. Nonendangered Species

Birds of Prey

Bald Eagle (*Haliaeetus leucocephalus*)

In the Arctic planning areas under consideration, bald eagles are casual summer visitors and are occasionally sighted on the North Slope of Alaska (Johnson and Herter, 1989). In the subarctic, bald eagles are common and conspicuous residents. They are distributed across forested areas south of the Brooks Range and in the Aleutian Islands and Kodiak Archipelago (Gerrard, 1983; ADFG, 1986; Stalmaster, 1987). Southeast Alaska can have particularly high concentrations of bald eagles during the winter. As of 1994, the Statewide population was estimated at 30,000 birds (Daum, 1994).

Breeding season for bald eagles in Alaska begins in late March and extends through early June. The largest concentrations occur in the Yakutat area in northern southeast Alaska (Isleib and Kessel, 1973). Adults tend to occupy the same breeding area each year and frequently re-use the same nest. Most nests are found within 3 km of a coastal area, river, lake, or bay. Nest sites are usually in trees, but are also found on cliffs. Bald eagles are opportunistic feeders. Fish constitute a major part of their diet. Herring, flounder, pollock, and salmon are typical prey species in coastal areas, while Alaska interior populations predominantly consume salmon (Daum, 1994).

Arctic and American Peregrine Falcons (*Falco peregrinus*)

The arctic peregrine falcon (*F. p. tundrius*) was removed from the endangered species list on October 5, 1994. The American peregrine falcon (*F. p. anatum*) was removed from the endangered species list on August 25, 1999, and will require monitoring for 5 years. In Alaska, the arctic peregrine falcon nests on cliffs and river bluffs on the North Slope and in the foothills of the Brooks Range, and the American peregrine falcon nests on cliffs in the interior. Peregrines are uncommon breeders and common migrants in the Aleutian Islands. Populations of both subspecies have been increasing (Wright and Bente, 1998).

Fall migration from the North Slope begins in late August and early September (Palmer, 1988). The primary migration route passes through the western interior of North America. However, some birds also migrate south through mountain passes in the Brooks Range and continue south through interior and south-coastal Alaska. A few birds occur, uncommonly but regularly, in coastal areas of the North Slope during the summer and fall.

In the subarctic, both subspecies occur uncommonly in coastal areas of the Gulf of Alaska and Lower Cook Inlet during periods of migration. During this time, they prey on the large numbers of shorebirds and waterfowl as they pass through. Small numbers of peregrines also breed along the northern Gulf of Alaska. Their nests are often associated with seabird colonies or waterfowl breeding areas (Isleib and Kessel, 1973). Peregrine falcons are rare but regular on the coast of the Gulf of Alaska during the winter.

Water Birds

Waterfowl including swans, geese, ducks, and loons occur as breeding birds and migrants in both the arctic and subarctic (Table 3-21). Primary marine habitats used include open water, islands, bays and lagoons, salt marsh habitats, and river deltas. However, some terrestrial habitats of the North Slope are used where pipelines, ice roads and pads, construction camps, and associated disturbances may occur.

In the Arctic, waterfowl occur only during the summer months when breeding takes place. Spring migration tends to follow the progression of ice breakup and is also influenced by wind direction (Divoky, 1983). Some waterfowl species (i.e., eiders and long-tailed duck) may migrate along offshore, coastal, or inland routes. Offshore migrants make use of leads in the ice to rest and feed (Johnson and Herter, 1989; Johnson, 2000). Geese, dabbling ducks, and scoters primarily follow inland routes along major drainages (Johnson and Herter, 1989). Birds begin to arrive on the breeding grounds from mid-May to early June. Courtship and breeding begin soon after arrival when snow disappears and terrestrial habitats become available to birds for feeding and nesting. Timing of breeding and incubation may vary from year to year depending on weather conditions, particularly the timing of snow melt (Troy Ecological Research Associates, 1997). Nesting densities in the Yukon-Kuskokwim River delta as high as 400 nests per square kilometer have been recorded. Since ice covers most of the area in winter, overwintering sea ducks and seabirds are concentrated in the St. Lawrence Island polynya, and in the ice front when present. Long-tailed ducks, murres, and other sea ducks can be abundant in these habitats. Openings in the ice front may contain densities as high as 10,000 murres per square kilometer (Divoky, 1981).

King and common eiders that winter in the Bering Sea migrate in May and June north past Point Barrow across the Beaufort Sea and nest in northern Alaska and Canada. During the molt and fall migrations (July through September), eiders pass close to Point Barrow, and head west and south to the Chukchi and Bering Seas. Suydam et al. (2000), compared estimates of king and common eiders migrating past Point Barrow in 1953, 1970, 1976, 1987, 1994, and 1996. They found the number of king eiders appeared to be stable between 1953 and 1976 (800,000 birds). By 1996, the king eider population declined by 56 percent to approximately 350,835. The number of common eiders passing Point Barrow during the spring declined by 53 percent, from 156,081 in 1976 to 72,606 in 1996. Reasons for the declines are unknown.

Complex, drained lake basins with diverse shorelines are frequently used by some nesting waterfowl. Nest sites of some species (i.e., king eiders) are commonly found near water (Anderson et al., 1998; Johnson et al., 1998). Small islands on lakes are also commonly used for nesting by loons, brant, Canada geese, eiders, swans, and other waterfowl species. Common eiders nest on barrier islands of the Beaufort and Chukchi Seas where they use driftwood for cover at nest sites. In recent years, snow geese and brant have nested on Howe Island in the Beaufort Sea near Prudhoe Bay (Johnson and Noel, 1996). A survey of lesser snow geese and brant in the western arctic coastal plain (between Point Lay and Harrison Bay) revealed that most nests were located east of Barrow and within 10 km of the coast (Ritchie et al., 2000). From 1995-1997, the mean number of adult snow geese in the region was 283 and 2,814 brant. After hatching, waterfowl broods may move several kilometers to brood-rearing areas on lakes or coastal salt marsh habitats (Troy Ecological Research Associates, 1996).

After breeding, waterfowl undergo a molt migration and staging period prior to fall migration. Beginning in early to mid-June, male long-tailed duck, eiders, scoters, loons, geese, and other waterfowl species leave the breeding grounds as incubation begins and move to coastal lagoons and estuaries to begin their molt (Johnson and Herter, 1989; Noel et al., 2000). Tens of thousands of birds utilize important molting and staging areas in the Beaufort and Chukchi Sea coasts (including Simpson Lagoon, Teshepuk Lake Special Area, Kasegaluk Lagoon, Ledyard Bay, and Peard Bay before migrating to wintering areas. Migration of females and young of the year does not begin until August or September. After molting, the fall migration may extend into September and October or early November.

Large numbers of ducks winter throughout the Gulf of Alaska especially in the Kodiak Island area and Prince William Sound. Common wintering species in the Kodiak Island area include long-tailed duck, emperor goose, greater scaup, mallard harlequin duck, and black scoter. Scoters are also common wintering birds in Prince William Sound, along with goldeneyes, harlequin duck, mallard, and mergansers (DeGange and Sanger, 1987; Isleib and Kessel, 1973). Nearshore benthic invertebrates, including mussels, clams, and other bivalves, gastropods, sea cucumbers, amphipods, and mysids, compose the main food items in the diet of diving ducks in the northern Gulf. Small numbers of swans and geese also winter in the northern Gulf of Alaska (Isleib and Kessel, 1973).

Waterfowl numbers peak in the northern Gulf of Alaska when millions of birds pass through the area during spring migration beginning in early April and continuing to mid-May, with some birds still passing through in early June. The Stikine River delta, the Copper River delta, Kachemak Bay, and Cook Inlet are important migratory stopover areas for swans, geese, and ducks during spring migration. Northern pintail are the most numerous of all duck species and are common breeding birds in Cook Inlet and the Copper River delta.

Numbers of waterfowl decrease during the summer breeding season after migrating birds have passed through the Gulf of Alaska. Some common duck species known to breed in the Cook Inlet and Prince William Sound areas include the northern pintail, mallard, green-winged teal, greater scaup, American widgeon, and northern shoveler (Isleib and Kessel, 1973; DeGange and Sanger, 1987). Trumpeter swan, Canada geese, and white-fronted geese also breed in these areas.

The fall migration of waterfowl from early-August to November is more protracted than the spring migration. During migration, birds use bays, fiords, tidal flats, and beaches. Some populations of Canada geese and brant appear to bypass the Gulf during southbound migration in favor of long-distance migrations directly to wintering grounds (DeGange and Sanger, 1987). However, snow geese commonly use river delta habitats in the Gulf of Alaska during fall migration. Other fall migrants include the common dabbling and diving duck species (Table 3-21).

Of special note is the Aleutian Canada goose, a small subspecies of the Canada goose (*Branta canadensis*) that breeds on the Semidi Islands and islands of the western Aleutians. The species was reclassified from endangered to threatened in 1990, and the USDOI, FWS, removed this species from the list of endangered and threatened wildlife on March 20, 2001 (66 FR 15643). The population has continued to increase and numbered approximately 32,000 individuals by 1999. The Aleutian Canada goose is still protected under the Migratory Bird Treaty and also is considered to be a species of special concern by the State of Alaska. Typically, they nest along the seacoasts of treeless islands and, in particular, on steep hillsides in areas densely vegetated by grasses, sedges, and ferns. Molting habitat is typically further inland. Aleutian Canada geese do not breed in the planning areas under consideration. The birds closest to the lower Cook Inlet area are the breeding birds on the Semidi Islands southwest of Kodiak Island. They also breed in the eastern Aleutians (e.g., Chagulak Island). Large numbers of Aleutian Canada geese are unlikely to occur in the subarctic planning areas, although stragglers may occur occasionally.

Shorebirds

Numerous shorebird species (such as plovers, sandpipers, and dunlin) occur as breeding birds and migrants in the arctic and subarctic planning areas (Table 3-22). As with waterfowl, and most other bird species, shorebirds are found in the arctic only during the summer breeding season. Shorebirds that breed in Alaska migrate long distances from wintering areas in the lower 48 States, Central and South America, and Pacific islands to breeding grounds on the arctic coastal plain and throughout Alaska. Although shorebirds nest in the subarctic, the most important areas for shorebird use in the environment affected by oil exploration and production are the migratory stopover areas in the northern Gulf where birds stop to rest and feed.

In the arctic planning areas, shorebirds arrive in late May or early June and establish territories on wetland habitats throughout the entire North Slope. Shorebirds tend to be solitary nesters. A delay in snowmelt may result in delayed nest initiation for some species (Mayfield, 1983; Troy Ecological Research Associates, 1992). Shorebirds begin nesting as soon as enough snow has melted to make terrestrial habitats available for nesting and feeding. They use most tundra types early in the breeding season, but shift to wet areas with more ponds where insect larvae are abundant for brood rearing. The breeding season is short, and some birds begin their fall migration by mid-July. For some species, adults abandon their young soon after fledging and begin their migration southward. Juvenile birds gather in flocks on wetland habitats before their departure in early to mid-August. During the breeding season, shorebirds are susceptible to predation by arctic fox, glaucous gulls, jaegers, and ravens.

The Yukon-Kuskokwim River delta, a major North American nesting and staging area for not only waterfowl but also shorebirds, lies adjacent to the southern boundary of the Norton Basin Planning Area (Norton Basin Sale 100 FEIS [USDOI, MMS, 1985]). Over 24 million individuals are estimated to use this area during the year.

An important location for shorebirds during migration in the subarctic is the western Cook Inlet (DeGange and Sanger, 1987). Kachemak Bay is adjacent to the lower Cook Inlet Planning Area and is also an important feeding and resting area for shorebirds during migration. Two other important locations in the Gulf of Alaska include the Copper River Delta at Prince William Sound, and the Stikine River Delta in southeast Alaska.

During spring migration, millions of shorebirds congregate on coastal intertidal mudflats to feed before continuing their northward migration. Most birds pass through the Gulf of Alaska between late April and mid-May, with the peak of the migration in early May. The largest number of migrating shorebirds occurs in the Copper River delta where 10-12 million birds may stop each spring (Isleib and Kessel, 1973). The two most common species are dunlin and western sandpiper. Three to four million western sandpipers may stop at the Copper River delta during a 4-week period in early spring before stopping at their tundra nesting grounds (Bishop et al., 2000). Their diets include small bivalves, amphipods, other invertebrates, and dipteran larvae. Turnover is high, and individual birds probably stop only to feed and rest for a few days before continuing.

As with waterfowl, the fall migration of shorebirds from late July to mid-October is more protracted than the spring migration. There is also some evidence that most individuals of some species (i.e., dunlin, red knot) may bypass the Gulf of Alaska in the fall, at least during some years (Isleib and Kessel, 1973). Although most species merely pass through the area during migration, a few species do winter in the northern Gulf of Alaska. Black oystercatcher, black turnstone, and rock sandpiper are fairly common winter residents on rocky shorelines. Sanderlings and dunlin may also occur in the area during the winter.

Seabirds

Seabirds occur in both the arctic and subarctic planning areas, although number of individuals and species richness are much greater in the subarctic (Table 3-23). Seabirds occur in the arctic during the summer breeding season but are found year-round in the subarctic. Almost all seabirds are colonial nesters.

In the arctic, only five species (two gulls, two jaegers, one tern) are considered to be common breeders (Table 3-23). Pomarine and parasitic jaegers, and Sabine's gull nest on tundra habitats while glaucous gull and arctic tern may nest on tundra habitats or on barrier islands. Jaegers feed on birds and their eggs, small mammals, insects, and occasionally seeds and berries. Glaucous gulls are opportunistic feeders and eat young birds and eggs, carrion, small mammals, and invertebrates; they are often seen at garbage dumpsters and refuse sites.

Black guillemots have shown the ability to adapt to manmade structures and have become more common in the Beaufort Sea area in recent years (Johnson and Herter, 1989). Black guillemots breed at scattered locations in the Beaufort and Chukchi Seas, with the largest colony located at Cooper Island near Barrow, where up to 450 breeding birds have been found (Johnson and Herter, 1989). Some black guillemots remain in the Beaufort during winter. Large seabird colonies are located at Cape Lisburn and Cape Thompson, where thick-billed murres and black-legged kittiwakes are the most abundant species. Guillemots and murres feed on crustaceans, mollusks, and worms, and small fishes are fed to the young. Most other seabird species that occur in the arctic planning areas are rare or accidental visitants during the summer months.

An estimated 2.2 million seabirds occupy colonies in and adjacent to the Norton Basin Planning Area during the breeding season (May-November). Major colonies or colony concentrations are found on St. Lawrence Island (1.8 million), King Island (246,000), Fairway Rock (47,000) and at Bluff (49,000) east of Nome (Sowls et al., 1978). Just to the north of this area, Little Diomede Island hosts 1.3 million seabirds (presumably Big Diomede Island contains comparable numbers). Norton Sound has a relatively small seabird-nesting population. Murres, auklets, puffins, and kittiwakes are the most abundant species.

In the subarctic, seabird breeding colonies occur along the coastline of the Gulf of Alaska and the lower Cook Inlet, although larger colonies occur in adjacent areas (DeGange and Sanger, 1987). Compared to adjacent areas, relatively few seabird species nest in the subarctic because of the lack of suitable offshore nesting habitat. In the Gulf of Alaska, the most common breeding seabird species are glaucous-winged and mew gulls, black-legged kittiwake, and arctic terns. Pelagic and red-faced cormorants breed near Cape St. Elias, just west of the Gulf of Alaska Planning Area, and large storm-petrel colonies are located southeast of the planning area. Species breeding in the lower Cook Inlet include glaucous-winged gulls; black-legged kittiwake; common murre, pigeon guillemot; horned and tufted puffins; parakeet auklet; and red-faced, double-crested, and pelagic cormorants. A number of other seabird species, including fulmars and storm-petrels, nest on nearby islands outside of the planning area, such as Kodiak and the Barren Islands, and on the Alaska Peninsula (DeGange and Sanger, 1987). Kittlitz's murrelet is found only in Alaska and the Russian Far East. A portion of this population breeds in Prince William Sound. They also concentrate on the Kenai Peninsula coast and in Kachemak Bay, numbering just a few thousand.

The largest concentrations of seabirds occur in the Gulf of Alaska during the spring, when returning breeding species and migrant nonbreeding southern hemisphere shearwaters move into the area. The numbers remain high during the summer and begin to decline in the fall around September as shearwaters depart for the southern hemisphere and breeding alcids disperse from coastal habitats (DeGange and Sanger, 1987). Seabird numbers are lowest during the winter; however, the Gulf of Alaska is still important for wintering species such as fulmars, fork-tailed storm-petrels, kittiwakes, and murres.

3.2.2.4. Fish Resources

Fishes are an important subsistence resource, so a large body of traditional and local knowledge about fish exists among user groups, especially Alaskan Natives. For many coastal Natives, fish is the single most important subsistence resource category. Fishes have been a primary concern for past oil and gas activities, particularly those that potentially affect the nearshore environment, such as the Endicott Project, or which involve major river crossings, such as Alpine.

3.2.2.4.1. Arctic

Fishes inhabiting the arctic must cope with harsh environmental conditions. For example, during the 8- to 10-month winter period, freezing temperatures reduce their habitat by more than 95 percent (Craig, 1989). Food is very scarce during this time, and most of their yearly food supply must be acquired during the brief arctic summer (Craig, 1989). As a result, fishes inhabiting the arctic grow slowly compared to those inhabiting warmer regions. Nevertheless, several types of fishes are year-round residents in the arctic. They include:

- freshwater fishes that spend their entire life in freshwater (some also spend brief periods in brackish coastal waters);
- marine fishes that spend their entire life in marine waters (some also spend brief periods in brackish coastal waters); and
- migratory, anadromous and amphidromous fishes that typically move between fresh, brackish, and marine waters for various purposes.

The freshwater environment of the arctic coastal plain consists of slow-moving rivers and streams as well as lakes, ponds, and a maze of interconnecting channels. Some water bodies are completely isolated; however, most are permanently, seasonally, or sporadically connected. Seasonally connected lakes are flooded during breakup, while sporadically connected lakes are flooded only during high-water years (Parametrix, Inc., 1996). Many of these waters support freshwater and migratory fish populations. At least 20 species of fishes have been collected in or near the Colville drainage system to the west (11 freshwater and 9 migratory species) (Moulton and Carpenter, 1986; Bendock, 1997). The distribution and abundance of freshwater and migratory fishes on the arctic coastal plain depend on (1) adequate overwintering areas, (2) suitable feeding and spawning areas, and (3) access to these areas (typically provided by a network of interconnecting waterways) (Parametrix, Inc., 1996). Studies on the Sagavanirktok River have shown that different fishes dominate at different times of the year, as shown below:

- **summer**: arctic grayling, round whitefish, Dolly Varden char (also called arctic char), broad whitefish, and slimy sculpin (Hemming, 1988; Woodward-Clyde Consultants, 1980).
- **late winter**: broad and humpback whitefish, arctic grayling, round whitefish, burbot, and slimy sculpin in the lower part of the river.
- **early spring**: broad and humpback whitefish, arctic and least cisco, arctic grayling, mud whitefish, burbot, and slimy sculpin.
- **spring**: broad whitefish, arctic and least cisco, arctic grayling, round whitefish, and burbot (Craig, 1989).

In winter, bodies of freshwater less than 2 m deep are frozen to the bottom (Craig, 1989). In deeper waters that do not freeze to the bottom, the amount of dissolved oxygen is of critical importance. Flowing waters exceeding 2-3 m in depth (depending on water velocity) generally are considered deep enough to support overwintering fishes. However, in standing waters the ice becomes thicker, and dissolved oxygen becomes less available as the winter progresses. In such cases, depths of up to 6 m have been suggested as being the minimum required to support overwintering freshwater fishes (USDOI, Bureau of Land Management [BLM], 1990).

The marine coastal environment of the Beaufort Sea consists of inlets, lagoons, bars, and numerous mudflats (USDOI, BLM, 1978a). During the open-water season, the nearshore zone of this area is dominated by a band of relatively warm, brackish water that extends across the entire Beaufort Sea coast. The summer distribution and abundance of coastal fishes (marine and migratory species) are strongly affected by this band of brackish water. The band typically extends 1-6 miles offshore and contains more abundant food resources than waters farther offshore. It is formed after breakup by freshwater input from rivers such as the Colville and Sagavanirktok. It has its greatest extent off river delta areas, with a plume sometimes extending 15 miles offshore. During the open-water season, migratory fishes tend to concentrate in the nearshore area, which is used also by marine fishes and occasionally by some freshwater fishes. Migratory fishes acquire nearly all of their yearly food supplies during the brief open-water season. The areas of greatest species diversity within the nearshore zone are the river deltas (Bendock, 1997). Sixty-two species of fish have been collected from the coastal waters of the Alaskan Beaufort Sea (69% marine, 26% migratory, 5% freshwater). All (except salmon) are typical of fishes resident to arctic coastal waters from Siberia to Canada (Craig, 1984). Thirty-seven species were collected in the warmer nearshore brackish waters, and 40 species were collected in the colder marine waters farther offshore (some use both habitats). As the summer progresses, the amount of freshwater entering the nearshore zone decreases, and nearshore waters become colder and more saline. From late summer to fall, migratory fishes move back into rivers and lakes to overwinter and to spawn (if sexually mature). In winter, nearshore waters less than 2 m deep freeze to the bottom. Before they freeze, marine fishes continue to use the nearshore area under the ice but eventually move into deeper offshore waters, when the ice freezes to the bottom (Craig, 1984).

All Pacific salmon are anadromous, meaning that they hatch in freshwater, migrate to sea, spend most of their life in the ocean, then return to freshwater natal streams to spawn and die. To date, little is known about the ocean life phase of Pacific salmon except that juveniles enter the ocean where they rear for 1-3 years. They may travel great distances during that period. Four of the five species of Pacific salmon range through both the arctic and subarctic of Alaska. The four species include chinook (*Oncorhynchus tshawytscha)*; chum *(O. keta)*; coho *(O. kisutch)*; and pink *(O. gorbuscha)*. Pink and chum salmon extend into the Beaufort Sea, and both have been captured in the Sagavanirktok River (pers. commun. W.J. Wilson, 2000); coho and chinook salmon occasionally reach the Chukchi Sea. Pacific salmon are important to commercial, subsistence, and sport fisheries throughout Alaska.

Subsistence fishermen harvest freshwater, marine, and anadromous fish in the area at differing times of the year, although the majority are harvested in summer. For example, summer fishing for whitefish occurs all around the Shaviovik River Delta, and Tom cod, sculpin, ling cod, flounder, and other marine species are taken in the Foggy Island area (North Slope Borough, Commission on History and Culture, 1980). In the spring, subsistence fishermen harvest arctic char as they migrate to sea and later, in summer, as the char move about in nearshore waters. In the fall, large migrations of whitefish and lake trout are fished along the Beaufort Sea shoreline in less than 1 m of water. Changes in fish populations have been observed by Wilson Soplu a subsistence fisherman, who noted that fish populations in the Shaviovik River have changed from many small fish, to fewer large fish (North Slope Borough, Commission on History and Culture, 1980).

3.2.2.4.2. Subarctic

The fishes of the subarctic are extensive and diverse. Many are migratory, spending part of their lives in the Gulf of Alaska and part offshore in deeper water. All five species of Pacific salmon are found in the subarctic. The sockeye (*Oncorhynchus nerka*) is the valuable commercial salmon species in Alaska, and the pink salmon (*O. gorbuscha)* is the most numerous. In addition to numerous fish species many types of shellfish and mollusks also inhabit this region.

Walleye pollock (*Theragra chalcogramma*) are the most abundant species of groundfishes targeted in the commercial fisheries of the North Pacific Ocean and are also fished throughout the Gulf of Alaska and the Aleutian Islands. Pollock occupy demersal habitats along the OCS and slope during winter and are found in large schools. They migrate into shallower waters and aggregate for spawning in late winter and spring. The pelagic eggs are in nearshore waters during their early development, with large concentrations found along the continental shelf. Pollock feed on a number of organisms such as mysids, euphausiids, and smaller finfishes (Witherell, 1999).

The Pacific halibut (*Hippoglossus stenolepis*) is a large commercially important flatfish harvested on the continental shelf throughout the North Pacific Ocean, primarily in the Gulf of Alaska. Slow-growing female halibut mature at about 12 years; males, however, mature much earlier. Halibut may reach 30 years of age. Females are much larger than males, attaining sizes in excess of 2.5 m in length and over 1,100 kg. Halibut spawn in deep waters during an extended period in the winter, but the eggs and larvae are in pelagic waters where they remain for 4 to 5 months before entering the benthos. There is no apparent geographical migratory pattern for this species, although there is an annual movement to and from deeper water. The largest fisheries occur in Gulf of Alaska waters, with smaller fisheries in the Bering Sea.

Pacific cod (*Gadus macrocephalus*) are widespread offshore demersal species of the continental shelf. In the Gulf of Alaska, Pacific cod is most abundant in the western gulf. The cod is a school fish and has a seasonal distribution, with the fish in deeper waters during the winter and spring, and in more shallow waters during summer. Larval cod range from pelagic to benthic waters, and they grow rapidly.

Pacific herring (*Clupea pallasi*) are abundant and widespread small forage fishes (up to 25 to 33 cm) that occur in large schools in the Gulf of Alaska in early April and possibly through early fall. Herring spawn in coastal and inshore waters throughout the Gulf region. Major spawning areas and fishes occur in southeast Alaska (including Sitka Sound), Prince William Sound, and Cook Inlet, and along much of the Shelikof Strait coastline of Kodiak Island. They are also found in the Bering, Chukchi, and Beaufort Seas (Hart, 1973). Herring stay nearshore until cold winter water temperatures drive them offshore to deeper, warmer waters. In the spring, herring migrate back to the littoral zone along the Alaskan coast. Female herring lay adhesive eggs over kelp, rockwood, other seaweeds, rock, and detrital substrates. Males fertilize the eggs by broadcasting milt over them. Depending on the size of the fish, the number of eggs may range from about 10,000 to 40,000.

Sablefish (*Anoplopoma fimbria*), or black cod, are managed as a directed fishery in the Gulf of Alaska. They are long-lived and occur along the OCS in water depths greater than 900 m. The species spawns in winter, and the eggs are pelagic, with the larvae near the surface. Juveniles are sometimes found in large schools in nearshore waters. Sablefish migrate extensively over long distances but without apparent timing or routing.

Rockfishes range from southern California to the Bering Sea. At least 30 rockfish species inhabit Alaskan waters, with Pacific ocean perch (*Sebastes alutus*) being the most common. Ocean perch are slow growing, bear live young, and reach a maximum age of about 30 years (Hart, 1973). Males grow more slowly and have shorter life spans. During the winter, a single female may release up to 300,000 live young.

Large quantities of crabs, shrimps, other shellfish, and mollusks are harvested from Alaska waters yearly. All of the species loosely categorized here as shellfish inhabit benthic regions as adults, but may occupy pelagic waters as larvae. While there are local spawning migrations, the crabs are essentially nonmigratory. Almost all of the Alaska crab harvest in 1997 (63,282 tons) came from the Bering Sea, excluding Tanner crabs (862 tons), which were harvested in southeast Alaska (USDOC, NMFS, 1999).

Pandalus (shrimp) landings in the Bering Sea and Gulf of Alaska are depressed after a drastic decline in the early 1980's. Since 1988, negligible amounts have been landed, all from southeast Alaska (USDOC, NMFS, 1999).

Norton Basin supports over 80 fish species that can be divided into three distinct groups:

- cold-water fishes indigenous to arctic-marine waters (e.g., arctic cod, longhead dab, and arctic flounder);
- fishes whose distribution is centered south of Norton Basin in the Bering Sea or the Pacific Ocean (e.g., salmon, saffron cod, yellowfin sole, starry flounder, Pacific herring); and
- anadromous freshwater fishes (e.g., char, whitefishes, and smelts).

Fish density in Norton Basin is considerably lower than in the northeastern Gulf of Alaska or the eastern Bering Sea. The pelagic fish resources utilizing Norton Basin are also less abundant, as suggested by multiyear catch statistics. Surveys in Norton Sound in 1976 showed that cods and flatfishes comprise over 75 percent of the demersal fish biomass in Norton Sound. Saffron cod accounted for nearly half of the biomass, and starry flounder accounted for about 10 percent (Nolotira et al., 1977). Shorthorn sculpin, yellowfin sole, and Alaska plaice were also relatively abundant. Although a relatively small portion of the Norton Sound fish biomass, arctic cod are estimated to be the second most numerous fish species in Norton Basin. Pelagic fishes utilizing Norton Sound include: five species of Pacific salmon, Pacific herring, rainbow or toothed smelt, capelin, other salmonids (char and whitefish), and other smelts. The Yukon River, which flows into Norton Sound, is the spawning ground for salmon which migrate through Norton Sound twice during their life cycle.

3.2.2.5. Coastal Habitats

The land-sea interface is a dynamic environment characterized by extremes in chemical and physical factors, including high salt concentrations, unstable sediments, frequent submergence, and anaerobic soils. This high variability is largely the result of tidal action and storm surges (Mendelssohn and McKee, 2000). Estuaries and associated salt marsh habitats are highly valued for their ecological uniqueness and their link to food webs (Mitsch and Gosselink, 1993) and nutrient cycles (Schlesinger, 1991)–features that underlie their wide use by bird and mammal populations. For these same reasons, coastal areas are particularly significant for human uses (including subsistence), and local residents are quite concerned about the potential effects of oil and gas activities on these areas and their resources (as evidenced in testimony for previous lease sales).

The areal extent of salt marsh and brackish marsh in the United States is 1,938,267 ha (Mendelssohn and McKee, 2000). Alaska salt marshes constitute 7 percent of the U.S. total (Hall, 1991). Well-developed salt marsh communities are unusual along the Alaskan arctic coast, and those that exist tend to be only a few meters in extent because of low tidal range and sea-ice action along the generally unstable and erosion-prone shoreline (Macdonald, 1977; Viereck et al., 1992). The most extensive salt marsh habitats occur in the deltas of the major rivers and a few protected bays.

The most important coastal wetlands and estuaries along the Beaufort Sea coast include Elson Lagoon, just east of Point Barrow; Fish Creek delta; Colville River delta; Simpson Lagoon; Canning River delta; Jago Lagoon-Hulahula River delta; and Demarcation Bay. Along the Chukchi Sea coast, the primary wetland-estuaries include Peard Bay; Kasegaluk Lagoon; Point Hope; Kotzebue Sound; Shishmaref Inlet; and Lopp, Ikpek, and Arctic Lagoons. Kasegaluk Lagoon appears to be the most important for marine and coastal birds (Johnson et al., 1992).

A number of chemical and physical factors influence benthic invertebrate communities in nearshore habitats, including sediment composition, water temperature and salinity, wave action, input of organic material, and sea-ice gouging. Sea ice physically disturbs sediments and limits the abundance and distribution of benthic organisms. In nearshore waters, bottomfast ice prohibits overwintering of most benthic species at depths of less than 2 m. Invertebrate aggregations in these areas are formed annually by recolonization during ice-free periods (Griffiths and Dillinger, 1980; USDOI, MMS, 1990b). Currents and wave action also disperse organic material from terrestrial sources throughout the marine environment. These organic materials provide a secondary food source for benthic invertebrates (Broad et al., 1979; Griffiths and Dillinger, 1980). Sediment grain size influences species composition, with fine sediments being dominated by deposit feeders and more coarse sediments supporting suspension feeding organisms (USAED, 1999).

Nearshore areas are characterized by epifaunal crustaceans, including mysids, amphipods, and isopods which are motile and opportunistic, as well as infaunal polychaetes and bivalves. Estuaries and coastal lagoons are characterized by large fluctuations in salinity and temperature. In winter, the exclusion of salt during ice formation and reduced water movement can locally increase salinity to 180 ppt, which sharply contrasts with summer salinities that range between 1 ppt and 32 ppt (Houghton et al., 1984). These highly saline conditions last until ice breakup or the penetration of freshwater runoff during spring. At breakup, the large influx of freshwater from ice melt and terrestrial runoff can create hyposaline conditions approaching freshwater. Temperature also fluctuates widely and rapidly at breakup, ranging from 0^{o} C to 14^{o} C (Craig et al., 1984).

Large estuaries and wetlands occur along the coast in the Cook Inlet/Gulf of Alaska region. The Copper River delta covers approximately 28,300 ha along the southcentral coast of Alaska, just east of Prince William Sound. The delta contains the largest contiguous area of coastal wetland on the Pacific coast of North America (Thilenius, 1995; Boggs, 1997). Extensive areas of salt marsh also occur in Prince William Sound, particularly along the Valdez arm (Crow, 1977), within the Cook Inlet-Shelikof Strait area, and along the south side of the Alaska Peninsula (USDOI, MMS, 1984a, 1996a). These marshes are dominated by *Carex* spp. and mixed grass/forb communities and provide habitat for millions of waterfowl and shorebirds and critical habitat for anadromous fishes, as well as feeding areas for numerous terrestrial and marine mammals. The delta of the Yukon River occurs along the southwest side of Norton Sound. The morphology of the outer perimeter of this extensive delta was reported by Grundlach et al., 1981; the beach types being primarily marshes, sheltered tidal flats, and eroding peat scarps.

In Cook Inlet and the Gulf of Alaska, plant and animal communities in rocky intertidal habitats have strong patterns of zonation with marked variation in species composition, community structure, and productivity (Lees et al., 1986). Invertebrate assemblages are richest in areas of high current flow and are generally more poorly developed in kelp beds. Invertebrates are concentrated below the seaweed zone, probably due to battering by kelps and surge activity (Lees et al., 1986). Suspension and deposit feeders that are largely dependent on organic debris dominate sand and mud assemblages. Sand beach epifauna are typically dominated by amphipods and polychaete worms, while clams and echiurid worms dominate mud flats (USDOI, MMS, 1996d).

3.2.2.6. Seafloor Habitats

Most of the seafloor in the arctic consists of a soft-bottom featureless plain composed of mud or sand, a generally unfriendly environment for the establishment of epibenthic communities. Cobble and boulders provide a more suitable substrate for epibenthos on the seafloor and are found distributed sporadically in the arctic. Although, large algae have been documented in areas that offer little hard substrate in the Beaufort Sea (Dunton et al., 1982), the largest described kelp bed in the arctic region is found at the Stefansson Sound Boulder Patch.

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The Stefansson Sound Boulder Patch provides habitat for a unique benthic community dominated by the large brown algae *Laminaria solidungula* (kelp). The diverse community associated with the kelp includes benthic bacteria, microalgae, and a variety of benthic invertebrates. Soft corals, sea anemones, hydroids, sponges, jellyfish, sea stars, crabs, nudibranchs, and mollusks are dominant invertebrates found at the Boulder Patch. The Boulder Patch harbors the largest kelp community thus far described in arctic Alaska (Figure 3-29). It is located in Stefansson Sound just seaward of the Sagavanirktok River delta near Prudhoe Bay (Dunton and Schonberg, 1981; Dunton et al., 1982; Dunton, 1984). Smaller epilithic communities have been reported in Camden Bay and in the eastern Beaufort Sea near the Stockton Islands, Flaxman Island, and Demarcation Bay (Dunton et al., 1982). Most Beaufort Sea substrates are silty sediments unsuitable for the settlement and growth of large algae.

Most linear kelp growth occurs in winter, with maximum growth occurring in late winter and early spring (Dunton et al., 1982). Approximately 98 percent of the biomass produced annually in the Boulder Patch is derived from kelps and phytoplankton. Dunton (1984) estimated that *Laminaria* contributed 50 to 56 percent of the annual production, depending upon the turbidity of ice cover. Kelps release about 60 percent of the particulate organic matter found in the Boulder Patch environment (Dunton, 1984). This input may be particularly important to the numerous filter feeders found in the epilithic community.

In general, the nearshore marine benthic community is dynamic and subject to disturbances due to storm activity, ice gouging and scouring, freshwater flow, and water circulation. Ice action can destroy benthic communities. Moving polar pack ice grinds against landfast ice in the “shear zone,” gouging sediments at approximately 15-25 m deep and physically disturbing habitat. Gouging decreases in intensity out to about a 40-m depth. Icebergs dragging deep keels scour sediment to water depths of approximately 60 m. This scouring can be as deep as 3 m and destroys habitat in its path.

Mobile, opportunistic epifaunal crustaceans (amphipods, mysids, and isopods) are characteristic of nearshore areas. Infaunal species include polychaetes, clams, and oligochaete worms that can burrow to safety. Few species are found in waters shallower than 2 m deep due to bottomfast ice that prohibits overwintering of most benthic species. Invertebrates recolonize these areas annually during ice-free periods (USDOI, MMS, 1996a). In general, epibenthic species diversity increases as water depth increases and the proportion of longer-lived sessile or sedentary species also increases. These species also increase with distance from shore and increased sediment stability (LGL Alaska Research Associates, Inc. et al., 1998).

Benthic invertebrates in the Chukchi Sea contain components of both Bering Sea and Beaufort Sea biota. Larval forms of some benthic invertebrates travel north along predominant currents through the Bering Strait into the Chukchi Sea. The influence of this transport decreases with distance from the Bering Strait. Benthic invertebrate fauna have been characterized as primarily boreal Pacific in the southeastern Chukchi Sea (USDOI, MMS, 1990b). Similarities between nearshore and littoral invertebrates in the northeastern Chukchi Sea and the Beaufort Sea were observed. This is attributed to the major physical condition similarities between the two seas, and to current reversals that bring larvae and food from the Beaufort Sea into the Chukchi Sea (USDOI, MMS, 1990b).

Offshore benthos in the arctic region has not been extensively studied. Two species groupings were noted in the northeast Chukchi Sea. One group is predominated by the polychaete *Maldane sarsi*, and includes the brittle star *Ophiura sarsi,* peanut worms *Golfingia margariticea*, and the bivalve *Astarte borealis*. The second grouping contains the bivalves *Macoma calcarea, Nucula tenuis,* and *Yoldia hyperborea,* and the amphipod *Pontoporeia femorata*. The organisms were found to be broadly distributed, but seem to accumulate by sediment type (USDOI, MMS, 1990b).

Epontic communities are composed of plants and animals living on or in the undersurface of sea ice (USDOI, MMS, 1996a). Most abundant in the bottom of the ice and the water just below the ice are pennate diatoms and microflagellates during spring in the Beaufort Sea (Horner et al., 1974). As light increases in the arctic in April, epontic populations develop, peak in May, and decline in June as the ice melts (Alexander et al., 1974). The peak of the bloom is important because epontic organisms provide food for zooplankton before the phytoplankton bloom.

Mollusks, polychaetes, and bryozoans dominate the infauna of seafloor habitats in the subarctic. Feder et al. (1981) found over 370 invertebrate taxa in samples from lower Cook Inlet. Substrates consisting of shell debris generally have the most diverse communities and are dominated by mollusks and bryozoans (Feder and Jewett, 1987). Muddy-bottom substrates are occupied by mollusks and polychaetes, while sandy-bottom substrates are dominated by mollusks. Where sediments are fine and sedimentation rates are high (particularly in the north-central region of the Gulf of Alaska), nearshore infauna consists mostly of mobile deposit-feeding organisms that are widely distributed through the area. Greater numbers of sessile and suspension feeding infauna occur in the western region (west of Prince William Sound) as sediment changes to sand/gravel. A relatively low biomass of deposit feeders occurs in the eastern Gulf of Alaska, an environment characterized by strong tidal currents and sediment of low organic content (Semenov, 1965). Infaunal organisms are important trophic links for crabs, flatfishes, and other organisms common in the waters of Cook Inlet and the Gulf of Alaska.

Epifauna are dominated by crustaceans, mollusks, and echinoderms. The percentage of sessile organisms in the subarctic region is relatively low inshore and increases towards the continental shelf (Hood and Zimmerman, 1987). Rocky-bottom areas consist of lush kelp beds with low epifaunal diversity, moderate kelp beds with well developed sedentary and predator/scavenger invertebrates, and little or no kelp with moderately developed predator/scavenger communities and a well-developed sedentary invertebrate community (Feder and Jewett, 1987). High epifauna biomass values – primarily from Tanner crab – occur to the west of Kayak Island where nutrients are probably concentrated along a frontal system of water moving into Prince William Sound along the eastern side of Hinchinbrook Entrance.

In Norton Sound, the abundant subtidal and benthic organisms include the brown alga (*Fucus)* and eelgrass (*Zostera)* on which herring deposit eggs that are harvested. The benthic animals include red king crabs that are also harvested. The benthic organisms on the north side of St. Lawrence Island include ampeliscid amphipods that are fed upon by migrating gray whales.

3.2.2.7. Areas of Special Concern

3.2.2.7.1. Essential Fish Habitat

The EFH has been established for groundfish resources of the Gulf of Alaska, Bering Sea, and Aleutian Islands. Section 3.1.2.8.1. defines and discusses EFH. Table 3-24 lists the fisheries with EFH established for the Gulf of Alaska and Cook Inlet Planning Areas. The EFH designations in the Gulf of Alaska and Cook Inlet Planning Areas are shown in Figure 3-30. Managed species for which EFH has been established in Norton Basin are listed in the paragraph below.

The EFH has been designated for 13 species in the Norton Basin planning area (North Pacific Fisheries Management Council, 1999). Included are, three species of crabs, (blue king crab, *Paralithodes platypus*; red king crab, *Paralithodes camtschatica*; snow crab, *Chinoecetes opilio*) that are present in various life stages, but only red king and snow crabs have EFH designations that include portions of Norton Sound. Five species of groundfish have EFH designated in Norton Basin (Alaska plaice, *Pleuronectes quadrituberculatus*; Pacific cod, *Gadus macrocephalus*; sculpin, spp.; walleye pollock, *Theragra chalcogrammer*; and yellowfin sole, *Limanda aspera*). All except Pacific cod have habitat in Norton Sound included in the EFH designation. All life stages of the five species of Pacific salmon of Alaskan origin (pink, *Oncorhynchus gorbuscha*; chum, *O. keta*; king, *O. tshawytscha*; red, *O. nerka*; silver, *O. kisutch*) have EFH designated throughout the Norton Basin Planning Area specifically including offshore areas of, and streams and rivers draining into, Norton Sound.

The EFH has also been established for five salmon species: chinook (*Oncorhynchus tshawytscha)*, sockeye (*Oncorhynchus nerka)*, pink (*Oncorhynchus gorbuscha)*, chum (*Oncorhynchus keta)*, and coho (*Oncorhynchus kisutch).* The EFH's for the salmon fisheries in Alaska within fresh water includes all streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon in the State. Marine EFH for both the Pacific salmon of Alaska origin and salmon stocks of Pacific Northwest origin include all estuarine and marine areas utilized by both stocks and extending from the influence of tidewater and tidally submerged habitats to the limits of the U.S. Exclusive Economic Zone (EEZ). It is the subset of habitat that occurs within the 320-km EEZ boundary of the United States in the Gulf of Alaska and Bering, Chukchi and Beaufort Seas to a depth of 500 m.

Research is now being conducted to better describe and identify EFH and impacts to EFH. The Auke Bay Laboratory in Alaska is currently conducting research assessing the importance of eelgrass and kelp habitats to juvenile salmon and groundfish, and developing juvenile groundfish sampling methods in nearshore waters.

Habitat Areas of Particular Concern

The HAPC's in Alaska are areas that have important ecological functions, are sensitive and vulnerable to human impacts, and are relatively rare. In general, living substrates in shallow waters include nearshore areas of intertidal and submerged vegetation and rock, which provide food and rearing habitat for juvenile groundfish and spawning areas for some species. All nearshore marine and estuarine habitats used by Pacific salmon, such as eelgrass beds, submerged aquatic vegetation, emergent vegetated wetlands, and certain intertidal zones, are sensitive to natural or human-induced environmental degradation. Finally, herring require shallow-water living substrates for reproduction. Spawning takes place near the shoreline. Their eggs are deposited on vegetation, primarily rockwood (*Fucus sp.*) and eelgrass (*Zostera sp.*) found along most of the coastline.

The HAPC's in offshore waters include substrates with high microdiversity, which provide cover for groundfish and other organisms. This may include rich epifaunal communities (coral, bryzoans) or with large particle size (boulders, cobble). Figure 3-29 depicts the location of the Stefansson Sound Boulder Patch in the Beaufort Sea Planning Area.

The HAPC's include all anadromous streams, lakes, and other freshwater areas used by Pacific salmon and other anadromous fish, especially in urban areas and areas adjacent to intensive human-induced developmental activities. Corals are generally slow growing and, therefore, are also considered HAPC. Both red tree coral (*Primnoa willeyi*), sea raspberry (*Eunephyta sp.*), and bamboo corals are known to occur in the southeastern part of the Gulf of Alaska.

3.2.2.7.2. National Parks, Wildlife Refuges, and Forests

National Park System

Seven national parks, preserves, and monuments in Alaska may be susceptible to direct impacts from OCS oil and gas development. Onshore oil facilities are permissible only on private acreage within each national park land. All seven of these properties contain privately held acreage, but the development of onshore oil support facilities is unlikely in four because of low logistical feasibility. Resources sensitive to impacts that may occur from oil and gas development in the OCS planning areas include the coastal vegetation and habitats; marine mammals and fishes that reproduce in, inhabit, or migrate through coastal areas; terrestrial mammals and birds that feed on these fishes; and terrestrial mammals and marsh birds and seabirds that inhabit or use the coastal habitats in the parks. Additionally, subsistence harvest is also allowed in some parks and may be impacted by offshore oil and gas development. Archaeological and cultural sites may also exist along the shoreline in some of the parks and may be susceptible to impacts. National parks, monuments, and preserves that border the Alaska OCS planning areas are listed below and shown on Figures 3-31 and 3-32.

- The Cape Krusenstern National Monument encompasses 267,128 ha of land and water in northwest Alaska. The Chukchi Sea borders the monument on the west, and the southern border is 15 km northwest of Kotzebue, Alaska.
- The Bering Land Bridge National Preserve covers over 1 million ha on the northern coast of the Seward Peninsula on the shore of Kotzebue Sound.
- Katmai National Park and Preserve was originally established in 1918 and covered just over 400,000 ha. The park has since grown by congressional actions and executive orders to approximately 1.48 million ha. The park is located on the eastern shore of the Shelikof Strait, about 300 km southwest of Anchorage.
- Lake Clark National Park and Preserve, established in 1980, covers 1.6 million ha located 1,500 km southwest of Anchorage, north of Lake Iliamna. The park borders Cook Inlet and extends over 1,500 km into interior Alaska.
- Kenai Fjords National Park spreads over 227,000 ha located 112 km southeast of Anchorage on the Kenai Peninsula.
- Wrangell-St. Elias National Park and Preserve is located in eastern Alaska and encompasses 5.3 million ha. The park boundary touches the head of Icy Bay and runs along the Gulf of Alaska coast before the Malaspina Glacier. The boundary follows the coastline to the east along the full extent of Yakutat Bay.
- Glacier Bay National Park and Preserve is located in southeast Alaska approximately 135 km northwest of Juneau and 965 km southeast of Anchorage. The park covers approximately 1.3 million ha, most of which is designated as wilderness.

National Wildlife Refuges

Oil facility development is prohibited on the Arctic National Wildlife Refuge (ANWR) and is discretionary on all other national wildlife refuges in Alaska. However, there are seven refuges that could potentially be affected by OCS oil and gas development from adjacent regions (Figures 3-31 and 3-32). Numerous refuge lands have been conveyed to private owners and Native corporations; Section 22(g) of the Alaska Native Claims Settlement Act of 1971 (ANCSA) requires that new development on these lands must be in accordance with the purpose for which the refuge was formed. Development of onshore facilities in support of offshore oil and gas development is, thus, technically possible but subject to intensive review. Three refuges (Alaska Peninsula National Wildlife Refuge, ANWR, and the Kodiak National Wildlife Refuge) may also contain subsea lands which would prohibit OCS oil drilling within varying distance from the shoreline. These subsea lands are presently under review. The specific resources subject to potential impacts from oil and gas development are essentially the same as discussed for the national park system above. In addition, subsistence hunting and fishing are permitted on all refuges in Alaska and could, therefore, be affected by accidents and routine operations.

- The ANWR comprises approximately 7.65 million ha of land in northeastern Alaska along the Beaufort Sea coast. An additional 277,000 ha are either selected for conveyance or have been conveyed, under the terms of ANCSA, to the State or to Native corporations. All federally owned land within the refuge is currently designated as wild rivers, minimal, or wilderness management status. However, 1.5 million acres (ANSCA Section 1002) along the northern coast has been set aside for further study and possible oil development, per ANILCA legislation.

- Alaska Maritime National Wildlife Refuge, Chukchi Sea Unit, covers approximately 120,000 ha extending from west of Point Barrow to just north of the Bering Strait near Cape Prince of Wales. Approximately 37 percent of the refuge is owned by the Federal Government, with the balance owned by the State of Alaska and a variety of Native-owned corporations.
- Alaska Maritime National Wildlife Refuge, Alaska Peninsula Unit, comprises approximately 286,000 ha in southwestern and southcentral Alaska. The unit includes more than 800 islands, and 146,000 ha consist of water, tidelands, and/or submerged lands. Except for 256 ha held as an intensive management unit, all lands are in minimal or wilderness management status.
- Alaska Maritime National Wildlife Refuge, Gulf of Alaska Unit comprises approximately 190,000 ha and extends over 1,931 km from Kodiak Island to Forrester Island in southeastern Alaska. Some waters, tidelands, and submerged lands are managed on Kodiak and Afognak Islands. On a case-by-case basis, oil and gas infrastructure can be constructed on these lands.
- Alaska Peninsula National Wildlife Refuge encompasses approximately 1.4 million ha along 510 km of the Alaska Peninsula in southwestern Alaska. Its northeastern boundary is 450 air km southwest of Anchorage. Becharof National Wildlife Refuge adjoins its border on the north, and the Izembeck National Wildlife Refuge adjoins the southern boundary.
- Becharof National Wildlife Refuge includes about 500,000 ha of land on the upper Pacific side of the Alaska Peninsula. Its northern boundary is about 472 km (by air) southwest of Anchorage. All lands within the refuge are in management categories that exclude all oil- and gas-related exploration and development.
- Kodiak National Wildlife Refuge is located primarily on Kodiak Island, with a satellite holding on the eastern side of Afognak Island. The refuge covers 660,000 ha and is all federally owned land. Current management categories do not allow oil and gas exploration and development or establishment of infrastructure related to oil and gas development to occur within the refuge.

The Yukon Delta National Wildlife Refuge is located partially along the southwest coast of Norton Sound. However, because only gas would be produced in Norton Basin and shipped by pipeline to shore, no impacts are expected on this Refuge, which predominantly does not allow onshore oil and gas infrastructure.

National Forests

National forest shoreline habitats and fauna using those habitats are susceptible to potential impacts from oil and gas development in the OCS planning areas (Figures 3-31 and 3-32). Alaskan national forests include the following:

- Chugach National Forest encompasses approximately 2.4 million ha of land in south-central Alaska. A variety of land uses are permitted within the national forest. Some land is designated as wilderness, while other portions of the national forest are open to mining activities. However, use of the land for establishing support facilities for oil and gas development are restricted.
- Tongass National Forest is the largest national forest in the United States. Located in southeastern Alaska, it stretches northward from the Dixon Entrance south of Ketchikan to the far edge of the Malaspina Glacier near Yakutat Bay. The heavily forested area contains many islands and has over 16,500 km of coastline, about one half that of the entire United States. The forest contains approximately 7 million ha, of which over 2 million are in 14 wilderness areas. Yakutat, located at the western edge of the forest, was one of the bases for previous OCS exploration activities in the northern part of the Gulf of Alaska. Any future offshore exploration would be expected to use Yakutat again.

3.2.3. Socioeconomic Environment

3.2.3.1. Population, Employment, and Regional Income

Tables 3-25 through 3-30 cover the State of Alaska census or Alaska Department of Labor units that most closely approximate the onshore areas of Alaska most likely to be directly affected by OCS oil and gas activities. Alaska has a relatively small population, estimated to be 622,000 in 1999, and a pattern of slow growth since 1993. This pattern is tied to general economic trends in the State, which depends on oil and gas production. While mortality and natural increase are relatively stable at the State level, annual migration varies greatly. As a result migration determines yearly population levels for Alaska.

The median age for Alaskans has been increasing consistently. Estimated median age was 32.4 years in 1998, 26.1 years in 1980, and 22.9 years in 1970 (Table 3-25). Projections of the State's age structure reinforces this dynamic (Table 3-26). While median age is not projected to increase as rapidly in the future, the Statewide population is expected to continue to age overall, as shown by the increasing "Aged Dependency" measure of Table 3-26. Males comprised 52 percent of the population in 1998. In terms of racial composition, Alaska's population in 1998 was 74 percent white, 17 percent Native American, 5 percent Asian and Pacific Islander, and 4 percent African-American (Table 3-27). Natives are differentially found in smaller communities, while other ethnic groups are differentially found in larger communities. The State classifies 70 percent of its population as "urban" and 30 percent as "rural."

Anchorage is the population and service center of the State, with an estimated 1999 population of 259,000 (42% of the total State). The Fairbanks North Star Borough and the Juneau Borough are the next largest communities, with populations of 84,000 and 30,000, respectively.

The Alaskan economy in general has become less dependent upon oil and gas production than in the past. This has come about not only through the growth of other economic sectors (and the Alaskan Permanent Fund), but also because of the decline in overall oil and gas production in the State. While the State of Alaska still generates 70 percent of its general fund revenue from the petroleum industry (historically between 75 and 90% since 1977–Goldsmith, 1998), this has declined annually by about 6 percent since the peak of production in 1988 (Goldsmith, 1999). Some analysts estimate that known reserves will be depleted by 2020 (Larson, 1998). However, this is a worst-case scenario and new discoveries and development undoubtedly will extend the date of last production.

The Government sector is extremely important for Alaska. Because of the large Federal presence in the State (i.e., U.S. Departments of Interior, Agriculture, and Defense), the Federal Government directly employs many Alaskans. In addition, the State receives a large percent of its budget from Federal sources in the same way that other States do, except that Alaska's share per capita is much greater than for most other States.

3.2.3.1.1. Arctic

The arctic includes the continental shelf of the Beaufort and Chukchi Seas and the Hope Basin, and the coastal communities associated with them (Figure 3-33).

Beaufort and Chukchi Seas

Table 3-28 covers the Beaufort Sea and Chukchi Sea Planning Areas, and Table 3-29 covers the Hope Basin Planning Area. The Beaufort Sea and Chukchi Sea Planning Areas are combined because they essentially encompass the waters offshore the NSB, making the NSB both a logical political and geographical unit. The NSB is composed of eight villages, various industrial-enclave settlements primarily related to oil and gas development, and various small and primarily automated military installations. Formation of the NSB was directly related to the development of oil and gas on the North Slope, and it has assumed most of the powers and responsibilities for service in the eight Native communities. Most NSB local revenues (about $39,000 per resident, highest in the State) are derived from property taxes imposed on oil and gas facilities. Estimated per capita income was about $23,000 in 1990 and about $24,000 in 1997 (Williams, 2000). The 1990 median household income was $50,000, and the 1990 poverty rate was 8.6 percent (Alaska Department of Community and Economic Development (ADCED), 2000).

Fifty-six percent of the total NSB population of 7,400 was Native American, 31 percent white, 11 percent Asian and Pacific Islander, and 2 percent African-American. Barrow is by far the largest regional community (population 4,400, or 60 percent of the total regional population). Most of the minority populations live in Barrow. Minorities in Barrow are non-Native Americans, while in the rest of the State and most other States, minorities include Native Americans and others, and whites are often the majority. The smaller NSB communities are predominantly American Native ($\geq$ 80 %) with small populations of whites and sporadic representation of other minority populations. Transient (i.e., nonresident) laborers of primarily white ethnicity are usually present in all NSB communities, and whites comprise the majority of the population formally enumerated at industry and military sites (72 in 1999).

The oil industry is the largest employer in the area. A primarily nonresident labor force of over 5,000 oil industry employees, composed mostly of non-Native Americans, is concentrated at the Prudhoe Bay and Kuparuk Fields. The Alpine Field near Nuiqsut is an additional enclave. The NSB is the largest employer of the resident workforce through government positions (especially in Barrow), NSB locally provided services, and Capital Improvement Program construction projects. The regional and village corporations established by the ANCSA also provide local employment. Only about 11 NSB residents hold commercial fishing permits. Subsistence resource use is important for NSB residents and is treated separately below.

The NSB population is younger than that of the State in general, less educated, and more predominately Native. These differences were greater in 1970 than in 1990 (or 1998), although not uniformly so; the median North Slope income is now greater than that for the State as a whole. This reflects the large tax revenues flowing to the NSB as a result of onshore oil and gas development.

Hope Basin

This area corresponds closely with the political and geographical boundaries of the Northwest Arctic Borough (NWAB) and the Kobuk census area, with the addition of the community of Little Diomede. This area consists of 11 predominantly Native communities, a mining industrial enclave, and a small-scattered population outside of named places. Estimated NWAB per capita income was about $15,000 in 1990 and $19,000 in 1997 (Williams, 2000). The 1990 median household income was about $33,000 and the 1990 poverty rate was 18.4 percent (ADCED, 2000). Of the NWAB population, 84 percent was Native American, 15 percent white, 1 percent Asian and Pacific Islander, and less than 1 percent African-American.

Kotzebue is by far the largest regional community, with 2,900 people. As is true in the NSB, most non-Native Americans in the NWAB live in Kotzebue. The smaller villages are predominantly Native. The industrial enclave is predominantly non-Native, although it employs a substantial number of local Natives (i.e., about 370 full time equivalents), and provides over 25 percent of the

NWAB wage and salary payroll. Other major employers in the area are the NWAB, Native corporations and organizations, and Veco Construction. Cash employment is limited in the smaller communities (outside of Kotzebue), and subsistence activities are very important. Approximately 169 NWAB residents own fishing permits. The population of Diomede City has limited wage employment opportunities, and relies heavily on subsistence resources.

The Northwest Alaska population is younger than that of the State in general, less educated, and more predominantly Native. This is a similar pattern to that in the NSB. A significant difference between the NWAB and the NSB is the lack of oil and gas development in northwest Alaska (although mining does provide an industrial base).

3.2.3.1.2. Subarctic

The subarctic includes Norton Basin and Cook Inlet/Shelikof Strait.

Norton Basin

In Norton Basin, Nome is assumed to be the marine and air support base for oil and gas activities. Nome serves as the transportation and economic center for the Norton Sound region. In 1990, Nome had 1,600 employed workers. Its population was 3,500 in 1990 and 3,600 in 2000. Alaska Natives represented 52 percent of the population in 1990. The median household income was about $46,000, and 9.9 percent of the residents were living below the poverty level in 1990. (ADCED, 2001)

In the Nome Census Area, which includes Nome and 15 surrounding villages, local government (mostly education) and services (health and social services) accounted for 66 percent of the employment in 1998. The employment total for all industries was 3,500. Population was 8,300 in 1990 and 9,300 in 1999, and average 1998 earnings per worker were about $28,000. Subsistence is also a significant part of the noncash economy for the predominantly Native population of Nome and the 15 villages (see Section 3.2.3.5.) (State of Alaska, Department of Labor & Workforce Development, 2001).

Cook Inlet

The Cook Inlet area is the most densely populated part of Alaska and is proximate to Anchorage, the Kenai Peninsula Borough (KPB), and the south coast of the Alaska Peninsula. Tables 3-25 and 3-30 pertain to this area.

The Cook Inlet Planning Area contains a complex mix of communities (Figure 3-34). Anchorage, discussed previously, is the largest community in Alaska. It functions as the service-distribution-transportation center for the oil and gas industry. Government and the military are important economic sectors, and about 900 Anchorage residents hold fishing permits for various fisheries throughout the State. The KPB has a population of 49,000 people, about 8 percent of the State population. Estimated per capita income was $21,000 in 1990 and $23,000 in 1997 (Williams, 2000). The 1990 median household income was $42,000, and the 1990 poverty rate was 7.7 percent (ADCED, 2000).

In terms of ethnic composition, the KPB population is 90 percent white. The KPB economy is very diverse, with many residents employed in the oil and gas industry (e.g., in Cook Inlet, on the North Slope, or in local refining or support services). Oil refining and support services have been developed in Kenai and Nikiski. Tourism, government, services, retail, construction, and fishing are other important economic sectors. About 1,600 KPB residents hold commercial fishing permits. Subsistence resource use is also important, especially for the small, non-road connected, communities of Tyonek, Seldovia, Nanwalek, and Port Graham. All but Seldovia are predominantly Native.

3.2.3.2. Land Use and Existing Infrastructure

Land use for the arctic and subarctic subregions (and planning areas as appropriate) are discussed here in terms of potential oil and gas activities and possible alternative/additional uses for those areas. Land use is closely related to and often dependent upon the developed infrastructure, and the two will be discussed together. The emphasis is on infrastructure developed for, or in support of, oil and gas exploration, development, and production activities. Oil and gas production facilities are concentrated on the North Slope (Beaufort Sea Planning Area), Cook Inlet, and the Kenai Peninsula. Transportation facilities are located in these same areas as well as the TAPS right-of-way and Valdez. Refining facilities are located on the Kenai Peninsula and outside of Fairbanks.

3.2.3.2.1 Arctic Subregion

The arctic subregion includes the Beaufort Sea Planning Area, which has a well-developed oil and gas industry infrastructure, and the Hope Basin/Chukchi Sea Planning Areas, which do not. Some of the Chukchi Sea villages benefit in terms of community infrastructure from their membership in the NSB, as a result of the NSB's taxation of oil and gas infrastructure.

Beaufort Sea

The dominant industrial land use in this area is for oil and gas activities, with limited alternative possibilities. Other mining possibilities (for nonpetroleum resources) may exist, but have not been established. Commercial fishing is limited to one operation in the Colville River delta. Tourism and recreation are elements of the area's economy, but are only significant in the principal town of Barrow. Even in Barrow, tourism is very seasonal and relatively undeveloped. The principal land use in the area is for subsistence activities. As discussed in Section 3.2.3.5, such subsistence uses are extensive, and are a vital component of cultural identity as well as an important contribution to household and community economies. Thus, the most significant land-use effects of oil and gas activities in this area are upon subsistence activities.

The largest oil field and the most extensive oil-production infrastructure in North America is located on the arctic coast of Alaska. The Prudhoe Bay and Kuparuk oil fields span the 114-km distance between the Colville and Canning Rivers, and contain hundreds of kilometers of service roads and feeder pipelines. In addition, this complex is connected by pipelines to the Endicott, Niakuk, and Badami Fields to the east (reaching Mikkelsen Bay) and will be connected by pipelines to the Alpine field to the west, in the Colville River delta on the border of the National Petroleum Reserve-Alaska. Endicott is an offshore development on two manmade gravel islands connected to the mainland by a gravel causeway. The Northstar unit is on a manmade gravel island connected to the mainland by a buried subsea pipeline. The offshore Liberty prospect may also be developed. This entire complex is served by the Deadhorse Airport, which possesses a 1,981-km airstrip and a great deal of associated enclosed storage. The TAPS transports produced hydrocarbons approximately 1,287 km south to the Alyeska terminal at Valdez. The Prudhoe Bay complex includes large docks and associated facilities to support the extensive exploration and production activities conducted on the North Slope. The Badami development also has a dock. The entire complex is also connected to the North American road network through the Dalton Highway to Fairbanks. In winter, the complex is connected to

Nuiqsut by an ice road. Except for local power production, all gas produced is reinjected to maintain formation pressure (USDOI, MMS, 1996d).

Airfields north of the Arctic Circle that can routinely handle jet aircraft exist in Deadhorse/Prudhoe Bay, Barrow, and Kotzebue. Other airstrips associated with villages, early warning stations (e.g., Distant Early Warning), and oil-industry work camps can commonly handle small jets and aircraft of the C-130 class. There are few roads in this region, and no deepwater ports. Waterborne cargo must be transported by barge. Industry shipments are transported via aircraft or barge to the Prudhoe Bay complex.

Chukchi Sea/Hope Basin

There is currently no oil and gas activity in this area, although exploratory activities have taken place in the past. Mining of zinc and lead occurs at the Red Dog mine, and deposits of coal with commercial potential exist south of Point Lay. Gold mining takes place at Nome. Commercial fishing opportunities are limited. As in the Beaufort Sea Planning Area, tourism and recreation are limited, and the primary land use is for subsistence activities. Similarly, the most significant land-use effects of oil and gas activities in this area are upon subsistence activities.

Little dedicated oil and gas exploration and development infrastructure exists in these areas or in Bering Sea communities in general. Rather, existing facilities (i.e., docks, airstrips, storage) have been used (and modified) as required. An offshore support facility was constructed in the port of Unalaska in the early 1980's to support a program of oil exploration. Airstrips most suitable to support industrial activity are located at Unalaska and Cold Bay. A number of communities have airstrips capable of handling jets and large propeller aircraft.

3.2.3.2.2. Subarctic Subregion

The subarctic subregion is much more diverse than is the Arctic, with a greater number of potentially conflicting land-use alternatives. Infrastructure is much more developed in general, and is much less directly related to specific oil and gas activities, other than for the TAPS and Valdez terminal facilities. Subsistence remains as an important alternative land use.

Norton Sound

In the Norton Sound area, most of the land is in Federal or Native ownership. The southern part of Norton Sound, from approximately the Yukon delta east to St. Michael, is part of the Yukon Delta National Wildlife Refuge (NWR); the northern portion of the Seward Peninsula is part of the Bering Land Bridge National Preserve; and various coastal islands, spires, and rookeries are part of the Bering Sea Unit of the Alaska Maritime NWR. Native ownership is concentrated along the coast.

Nome is the regional center of Norton Sound and the largest city in western Alaska. The city has a hospital, a correctional facility, and a community college. Water and sewer services are available in the Nome town site, with water storage apparently adequate for both offshore drilling and residents. Nome has a State-maintained airfield suitable for use by medium-sized jet aircraft and medium-sized cargo planes, as well as a smaller municipally maintained light plane airstrip. The Port of Nome has a 2,712-foot causeway with marine headers on the outer dock for the community's bulk fuel deliveries. This particular dock (outer) is approximately 200 feet in length and accommodates vessels with up to a 19 foot-draft (MLLW). The inner dock is 190 feet in length and will handle vessels up to a 12-foot draft (MLLW). From this port, container cargo is sent by barge to surrounding village communities, or by truck along Nome's 385-mile highway system to inland communities and gold camps. Armor rock, sand, and gravel are exported for construction in the Norton Sound area. This road system is not connected to the rest of the State.

Other locations that could provide support for offshore drilling operations are the communities of St. Marys and Unalakleet. Both communities have air strips that could and do accommodate medium-sized jet and cargo aircraft. However, neither locations has suitable port facilities.

Cook Inlet and Kenai Peninsula

Cook Inlet is important as a producer of natural gas, for commercial and recreational fisheries, and for tourism and recreation. Thus, numerous potential land-use conflicts and effects exist. Subsistence use of Cook Inlet is limited, due to the urban nature of most of the population in the area and Federal and State regulations. However, Alaskan Natives are allowed to hunt sea mammals, and in the past, the subsistence harvest of beluga whale has been significant.

Oil was first discovered on the Kenai Peninsula in 1957, and this area and Cook Inlet were intensively explored for their oil and gas potential in the 1960's. Oil and gas are produced both onshore and offshore on State lands, and some Federal leases in Cook Inlet are currently active. Some gas is piped to Anchorage for power and heat generation. The balance of the gas is piped to a liquefied natural gas plant in Nikiski for liquefaction and shipment to Japan, or is used to manufacture fertilizer. Produced oil is piped to the Drift River tanker-loading facility. Facilities on both the Kenai Peninsula and in Anchorage have been used to fabricate large support modules for oil and gas development and production. The Port of Anchorage is generally limited to the use of barges and small container ships, due to its shallow water depths. The petroleum docks at Nikiski and Drift River are designed to accommodate tankers with up to a 600,000-barrel capacity. In general, Kenai Peninsula facilities are positioned to support activities in Cook Inlet, and not those in the Gulf of Alaska.

The Kenai Peninsula and Cook Inlet area has an extensive road network, and is served by the Stevens International Airport in Anchorage as well as numerous smaller air facilities. Anchorage is the State center for scheduled aircraft, and is the regional center for chartered aircraft. Anchorage is also the center for the State's overall road network.

Gulf of Alaska and TAPS-Associated Communities

Residents of Gulf of Alaska communities participate in a variety of fisheries, as well as a wide range of subsistence activities. These represent major potential alternative land uses to oil and gas activities. Sports fishing, tourism, and less formal recreation are also important economic activities and represent potential alternative land uses. Mining and timber harvest also occur, but are less likely to conflict with potential oil and gas activities, although they may compete for the use of limited infrastructure. Oil and gas infrastructure is concentrated in Valdez, which is the site of the TAPS terminal. No oil and gas exploration, development, or production activities occur in the Gulf of Alaska, aside from those associated with the terminal in Valdez and the transport of oil by tanker.

The Alyeska terminal is located in the deepwater port of Valdez. A limited variety of products are refined in a facility near Fairbanks and transported to Anchorage via the Alaska Railroad. The railroad also connects with Seward to the south of Anchorage. Only limited, dedicated oil and gas development and exploration infrastructure exists in the Gulf of Alaska. Valdez contains facilities to receive and store oil from the north, and to load it onto tankers. These facilities are not built to support oil and gas exploration and development. While natural deepwater harbors exist in the Gulf of Alaska, few dock facilities capable of handling deepwater containerized or bulk cargo ships are present. Kodiak and Seward, located in the western Gulf of Alaska, do have such facilities but are relatively distant from that part of the Gulf of Alaska potentially available for oil and gas exploration and development. In the eastern Gulf of Alaska, there are many small fishing ports and several log-loading facilities. Yakutat, a fishing community, has dock facilities adequate for commercial fishing and processing, and other community needs. Additional facilities may need to be developed to support oil and gas exploration and development in the area, should there be industry interest.

3.2.3.3. Fisheries

Fish have always been an important resource in Alaska. Fishing and fish resources are incorporated into Alaskan Native culture and livelihood in all parts of the State, and fish are the main subsistence food. About 65 percent of the State's subsistence harvest by weight is fish, including salmon, halibut, herring, whitefish, cod, and Arctic char-Dolly Varden, among others (Wolfe, 2001). Traditional dried herring remains a major staple of the diet in Bering Sea villages near Nelson Island. In the spring, Southeast Alaska natives collect herring roe from hemlock branches on which the fish spawn (Funk, 2001).

The desire to manage commercial salmon fisheries locally was a prime motivation for the Alaska statehood movement. Many different fisheries in the State have been developed since statehood was granted in 1959, and the fish industry is one of the most significant employers and generators of income in the State. It is particularly important in coastal communities, and for some is the major support of civic government (through fish taxes) as well as the primary local economic activity (harvesting and/or processing). The interrelations of fisheries can be quite complex. Many Alaskan fishermen participate in a number of fisheries with relatively small (< 18 m), multi-gear boats. Others fish with larger vessels that tend to be more specialized in terms of gear and fishery participation. Many out-of-state fishermen also participate in Alaskan fisheries. Salient references for a characterization of Alaskan fisheries have been prepared for the North Pacific Fishery Management Council and the State of Alaska Commercial Fisheries Entry Commission (Alaska CFEC). For example, see reports prepared by Impact Assessment, Inc. (IAI) (1991, 1994a, 1994b, 1998) or Terry and Hiatt (1999).

3.2.3.3.1. Arctic

In the Beaufort Sea, there is a single commercial fishery in the Colville River delta that operates in the summer months and targets cisco and whitefish. Markets for these fish are primarily regional, although some fish are sent to Anchorage and to more distant markets. Aside from a relatively small chum salmon fishery in Kotzebue Sound, there are no commercial fisheries in the Chukchi Sea and probably few prospects for any due to the relative lack of resources.

3.2.3.3.2. Subarctic

Norton Sound

The commercial-fish resources of Norton Sound include salmon, herring, and red king crab. There are two distinct red king crab fisheries. The first occurs between November 15 and May 15 and is a nearshore, *through-the-ice* fishery used exclusively by Nome-Norton Sound area residents for commercial and subsistence purposes. The second occurs in August and is an offshore fishery used exclusively by large, out-of-region, commercial fishing vessels.

Alaska’s commercial catches are divided into four regions by the ADFG. The Norton Sound area is included within the region they refer to as the Arctic-Yukon Kuskokwim Region. It includes three large areas, Kotzebue Sound, Norton Sound, and the Kuskokwim area. The Arctic-Yukon Kuskokwim Region's contribution to the commercial catch of the four regions is: salmon 2 percent, herring 21 percent, and red king crab less than 1 percent (ADFG, 1997). These percentages also include catches of salmon taken in Kotzebue Sound and any salmon, herring, or red king crab taken in Kuskokwim area. Hence, the actual contribution of the Norton Sound area to Alaska's commercial catch of salmon, herring, and red king crab is likely to be lower than the percentages reported here. This is particularly the case for salmon, as the majority of the Arctic-Yukon Kuskokwim Region commercial salmon catch (sockeye, coho, and chum) is harvested in the Kuskokwim area.

Cook Inlet

Commercial fishing is an especially significant component of the Kenai Peninsula economies of Kenai, Soldotna, and Homer. Anchorage residents also hold a significant number of Cook Inlet commercial fish permits. The most significant fishery is usually for salmon, predominantly for sockeye harvested mainly by drift and set gillnets. Halibut, tanner crab, and shrimp are also part of the Cook Inlet fishery complex.

Gulf of Alaska

This is a very broad area, extending from Kodiak and the south coast of the Alaska Peninsula to southeast Alaska. The area being considered for oil and gas exploration and development, located offshore of Yakutat, is important primarily for salmon, sablefish, halibut, and a limited amount of pollock, with some harvest of rockfish and bycatch associated with these fisheries. Yakutat's economy is quite dependent on these fisheries. Other than for salmon, offshore Yakutat is not the most productive part of the Gulf of Alaska. Kodiak is the dominant fishing community in the Gulf of Alaska, especially in terms of harvesting and processing of groundfish other than halibut. Kodiak is also an extremely important community for other fish species, but harvesting and processing capabilities are more dispersed for these fisheries. Significant Gulf of Alaska fisheries are very diverse. All species of salmon are taken (especially pinks, sockeye, and chum) with setnet, gillnet, and purse seine gear. Pollock (and flatfish other than halibut) are harvested with trawl gear. Cod are harvested with pot and longline gear. Halibut and sablefish are taken with longline gear. The spring herring sac-roe fishery is also quite significant.

> Sac roe fisheries harvest herring just before spawning using either purse seine or gillnet gear. A lucrative market for herring eggs and eggs on kelp prompted the development of Alaska's roe herring fisheries and remain the principle utilization of herring at present. Pacific herring also are an important food source for other species. (Funk, 2001)

Rockfish are also targeted, primarily with longline gear by smaller boats. The Gulf of Alaska crab stocks have recently declined greatly, but in the past, this has also been a very significant fishery pursued with pot gear. Shrimp is also still available locally in limited quantities, but was a very significant fishery in the past, fished with trawl gear. Detailed information on the characteristics of fisheries sectors and their distribution among Gulf of Alaska communities, can be found in Northern Economics (1994). More recent and very detailed information can be found on the web site for the Alaska CFEC (Alaska, CFEC, 2001). The web site for the NMFS Alaska Regional Office (USDOC, NOAA, NMFS, 2001) also provides useful information in this regard.

3.2.3.4. Tourism and Recreation

3.2.3.4.1. Arctic

On the North Slope (Beaufort and Chukchi Sea areas), most nonresident recreational activity takes the form of tour groups, primarily visiting Barrow or Deadhorse. Both locations have lodging available; indeed, Barrow has developed a limited tourism sector. Travel is primarily by air, although bus tours occasionally arrive via the Dalton Highway between Deadhorse and Fairbanks. Hikers and river rafters also visit the ANWR and other areas, using scheduled (to Kaktovik) or chartered (for remote locations) airplanes for access. Lodging is currently available in Kaktovik, out of which a charter air service operates. Gates of the Arctic National Park receives limited visitation (access through Anuktuvuk Pass or chartered airplane). Hunters also visit the area employing aircraft for access. Some hunters may enter the area from the Dalton Highway; however, such access is limited because hunting is restricted within the right-of-way.

Activities in the Hope Basin area, and the Chukchi Sea south of Point Hope, are similar to those of the North Slope. Tour groups visit Kotzebue, which has a tourism sector similar to Barrow, on a regular basis. Visitation is relatively limited to smaller communities, or more remote locations and the national conservation units in the area (Cape Krusenstern National Monument, portions of the Alaska Marine National Wildlife Refuge, Bering Land Bridge National Preserve, Selawik National Wildlife Refuge). Hikers and river rafters certainly come to the area, as do hunters from other parts of Alaska (and perhaps outside of Alaska).

3.2.3.4.2. Subarctic

Opportunities for recreational activities such as hunting, hiking, boating, and sightseeing are abundant in the Cook Inlet area. Tour ships from the lower 48 States regularly traverse southeast Alaska, and many independent travelers use the Alaska Maritime Highway (ferry) system to access the region. Helicopter and small aircraft sightseeing tours have developed locally, along with a generally robust tourism sector. This includes a fleet of small regional tour ships, river jet-boat tours, fishing charters, bed and breakfast operations, and associated tourism-based enterprises.

The Kenai Peninsula and Prince William Sound are in close proximity to Cook Inlet and Anchorage, which is the population and logistical center of the State. Thus, these areas receive the heaviest recreation use, both by residents and nonresidents. The Kenai Peninsula has a developed road system and is directly connected to Anchorage. Prince William Sound was recently connected by road to Anchorage as well, via Whittier. Local boat tours of Prince William Sound and Kenai Fjords National Park are popular attractions. Rivers and streams in the area, especially the Kenai River, are heavily fished. The Kenai Peninsula is also a popular hunting area. The Chugach National Forest attracts hikers, campers, and other users. An extensive tourism infrastructure is centered in Anchorage and extends into the surrounding region.

Except for a few hunters and fishermen, the Norton Sound region has very little developed tourism or recreation. However, certain areas in the Norton Sound region have been identified as having tourism and recreation potential by the Alaska Division of Parks and the Joint Federal-State Land Use Planning Commission. The entire coastline of the Norton Sound region has visual and scenic value. The historic community of Nome owes its existence to the nearby discovery of gold in 1898. Nome was, for a while, Alaska’s largest city. Gold mining still continues near the community, and it has retained some of its frontier characteristics. Nome is also the end point of the Iditarod sled dog race, which draws hundreds of tourists to the finish line each year.

3.2.3.5. Sociocultural Systems

A sociocultural system encompasses the social organization, behavior, and values of the society. The sociocultural systems described in this document are regional and community systems that might be affected by future oil and gas operations. For most Alaska Natives, if not all, subsistence (and the relationship between people, on the one hand, and the land and water and its resources, on the other hand) is the idiom of cultural identity. It is important to consider the cultural identity of the Native people in terms of the sociological concept of "place." This concept is comprised of three components that are key elements in understanding sociocultural systems. First, "place" is essential and spiritual. That is, it has a fixed and true meaning based on social facts and is an engulfing ideology. Second, it is socially constructed. It is negotiated, dynamic, and contested over time. This takes into account what the "place" was like in the past, what it has become and how it has changed. Finally, the "place" is based on geography. It has boundaries, and residents are connected to it as a geographic location where daily "social action" occurs. Much of this "social action" is in the form of subsistence.

All fundamental issues can be and are discussed in terms of potential effects upon subsistence activities. The EIS for Lease Sale 170 summarized the major Inupiat concerns with the proposal into five categories, all involving effects on subsistence resources. The last of these was the ". . . insufficient recognition of Inupiat indigenous knowledge concerning subsistence resources, subsistence harvest areas, and subsistence practices" (USDOI, MMS, 1998). It is difficult to summarize traditional and local knowledge in any meaningful way, but the reader is referred to the more focused "subsistence" discussion below.

Sociocultural systems are dynamic and influenced by many interacting causes and effects. Oil and gas development is only one element inducing and influencing sociocultural change in Alaska. The history of Native and Euro-American contact, the attainment of statehood, and many other factors have combined to shape recent sociocultural change. The federal legislative conjunction of these processes, the ANCSA and ANILCA also contributed to major changes in social organization and cultural value systems (Chance, 1966, 1990; Arnold, 1978; Klausner and Foulks, 1982; Berger, 1985; Downs, 1985). Economic activity, broadly defined, is a basic determinant of sociocultural change, and will be the starting point in assessing change. Analysis of subsistence, the most dominant nonmonetary economic activity in rural Alaska, is examined below.

3.2.3.5.1. Regional Communities

Beaufort and Chukchi Seas (North Slope Communities)

Aboriginal North Slope social organization is not well known in terms of local detail (Oswalt, 1967; Damas, 1984; IAI, 1989a, 1990d; Ray, 1885; Murdoch, 1892; Nelson, 1899). The broad model of precontact North Slope social organization based on this evidence consists of a dynamic system composed of small kinship-based territorially defined "nations" of subsistence hunters (Chance, 1966; Burch, 1975, 1998; Damas, 1984).

Although Euro-American contact greatly influenced Inupiat social organization, the fundamental organizational feature is that of kin-related groups engaged in subsistence activities. Euro-American contact introduced new resources (such as food items and technology) that enhanced subsistence hunting and wage-earning opportunities, as well as many other agents of change (Salisbury, 1992). Development of the oil industry on the North Slope transformed the economic basis upon which the North Slope region as a whole operated, but not the importance of kinship-based social organization.

Historically, perhaps the most significant social changes include the Inupiat adoption of Euro-American technology and the shift in Inupiat settlement patterns from a system of many small, territorially confined, local groups to that of a more limited number of large, permanent, communities located within a shared regional territory. The formation and actions of the NSB and its constituent communities are the most concrete expressions of these cultural continuities—a successful result of the adoption, integration, and manipulation of "modern" resources within an Inupiat sociocultural system (Hopson, 1976, 1978; Morehouse and Leask, 1978; McBeath, 1981; Morehouse et al., 1984; Harcharek, 1995; Shepro and Maas, 1999).

Prior to the discovery and development of oil and gas on the North Slope, and the formation of the NSB in 1972, the population of the five then-existing villages (i.e., Barrow, Kaktovik, Anaktuvuk Pass, Point Hope, and Wainwright) totaled about 2,500 people. Each village had limited political power, social services, and infrastructure. Per capita and household incomes were low, both in absolute and relative terms, and North Slope residents relied heavily on local subsistence resources for food, clothing, and heat (Van Valin, 1945; Ingstad, 1954; Sonnenfeld, 1956; Foote, 1959, 1960a, b, 1961; Spencer, 1959; Vanstone, 1962; Gubser, 1965; Nelson, 1969; Brosted, 1975).

Considerable information exists in literature on the history and current dynamics of the NSB socioeconomics, including the resettlement of three communities since 1970 (Nuiqsut, Point Lay, and Atqasuk). A regional overview and a discussion of each community is provided in IAI (1990c), as well as within MMS documents previously cited. Both the State and the North Slope communities have grown significantly since 1939. The State grew at a rate that was approximately 1.5 times that of the North Slope communities between 1939 and 1970. After 1970, as North Slope oil was developed, the reverse was true. The majority of NSB growth since 1970 has been in the three communities established after the incorporation of the NSB. Large investments have been made in the infrastructures of all NSB communities.

There have been over 20 years of public hearings and meetings on State and Federal oil development on the North Slope. Residents of the North Slope have been remarkably consistent in their primary concerns during that time. This document, due to space constraints, cannot adequately reproduce and acknowledge these many contributions, but other recent documents make at least a start in this regard (USDOI, MMS, 1996a, 1998; USAED, 1999—incorporated by reference). In the interest of brevity, we have summarized several of the main categories of Inupiat concern in the following bullets and quotations. Many are of course interrelated, as local and traditional knowledge is based on personal life experience, and are usually cited and learned in a rich personal and cultural context. The isolated "examples" with each bullet are only examples, but provide at least a minimal guide for the reader in understanding the context from which the generalized concern was formed. This context will be further developed in the analysis of potential effects in Chapter 4.

- Marine mammals, and especially whales, are sensitive to noise. Hunters avoid making any sort of extraneous noise, and the loud and relatively constant noises associated with seismic testing, drilling, and boat and air transport will cause whales (and other marine mammals) to avoid areas where such noise is audible to them. The range of whale sensitivity to noise is quite large:

> Thomas Napageak – Something that we can hear, the whales will hear many miles away. That's why we have always been – have never landed whales here in our community due to activities when (indiscernible) [probably related to oil and gas activities] were underway. Because of seismic through traffic, helicopter overflights, these were the cause of the whales migrating further north out to the ocean . . . . (USDOI, MMS, 1996a).

Lloyd Ahvakana – The Inupiats have existed along the northern and western coast of Alaska for many thousands of years. This existence is based on subsistence and has culturally tied us to the bowhead whale and to the rest of the marine and animal life of our land. The people and marine and animal life has already been affected by oil and gas development. This development has also forced the bowhead whale to migrate further off the coastline of Barrow (USDOI, MMS, 1982a).
Thomas P. Brower, Sr. – The whales are very sensitive to noise and water pollution. In the spring whale hunt, the whaling crews are very careful about noise. In my crew, and in other crews I observe, the actual spring whaling is done by rowing small boats, ... until the whale has been hit with the whaling bomb. We keep our snow machines well away from the edge of the ice so that the machine sound will not scare the whales. In fall whaling, we used to only use small boats or rowing to go after whales, but in the last 15 years we have started to use motors. In the fall we have to go as far as 65 miles out to sea to look for whales. I have adapted my boat's motor to have the absolute minimum amount of noise, but I still observe that the whales are panicked by the sound when I am as much as 3 miles away from them. I observe that in the fall migration, the bowheads travel in pods of 60 to 120 whales. When they hear the sound of a motor, the whales scatter in groups of 8 to 10 and they scatter in every direction (Brower, 1978).

Arnold Brower, Sr. – You all know me, I am Arnold Brower, Sr. I also made it to the times that these elders were telling you about. I was a boy helper to Vincent [Nageak] and I started learning from him, watching my elders whale hunting and following along . . . . Their teachings are all true, the whale can smell, see, and hear. This I have found out myself . . . . [A]ny noise or playing around is forbidden at whale hunting camps. I completely back up what Vincent Nageak, Elijah Kakinga, Bert Okakok, and Otis Ahkivivgak told you about our way of life which has been from the beginning. I want it left alone (AEWC, 1977).

- Any given oil spill may be a relatively low probability event, but over the long run the probability of at least one such spill occurring is quite high. Oil spills are likely to have the largest and longest lasting effects upon the Inupiat people, primarily in terms of subsistence activities:

Native Village of Nuiqsut, City of Nuiqsut, Kuukpik Corporation – Our overriding belief is that . . . there is a 100% chance of an oil spill and an 85% chance of a major spill . . . . The EIS underestimates the magnitude of both major and catastrophic spills and dramatically underestimates its impact on both our subsistence harvest and upon our society (USDOI, MMS 1996a).

Arnold Brower, Sr. – Any accidents of oil spill would have a devastating impact to the bowhead population if encountered by a large migrating school that happens to want to pass through their natural migratory pattern (USDOI, MMS, 1990c).

Archie Brower – The whole place from the mountains to the ocean is just like our garden. We feed on it. If there's a major blowout on the ocean, if that happens, the ice goes out, it's going to take that oil all along the coast . . . . and it would destroy our fish, seals, and whales (USDOI, MMS, 1979).

Thomas P. Brower Sr. – In 1944, I saw the effects of an oil spill on Arctic wildlife, including the bowhead. . . . August, 1944, one of the cargo ("Liberty") ships ran

> aground on a sandbar off Doctor Island at Elson Lagoon. They needed to lighten the ship to get free. To my disgust . . . they simply dumped the oil into the sea. About 25,000 gallons of oil . . . . The first year . . . I observed how seals and birds who swam in the water would be blinded and suffocated by contact with the oil. It took approximately four years for the oil to finally disappear. I have observed that the bowhead whale normally migrates close to these islands in the fall migration . . . But I observed that for four years after that oil spill, the whales made a wide detour out to sea from these islands . . . . If there were a major blowout, all the Inupiat could be faced with the end of their marine hunting. . . . (Brower, 1978).

- Many NSB residents believe that the technology to clean up oil spills in arctic waters, and especially in broken ice conditions, is poorly developed and has not been adequately demonstrated to be effective.

> Morgan Solomon – Even if we say to go ahead and develop the land there is no known technology to protect it if there should be a blowout . . . the oil companies within the Prudhoe area do not have modern equipment to stop any blowout and they know it (Alaska Department of Natural Resources [ADNR], 1978).

- One of the most important mitigating measures proposed repeatedly by the NSB, if offshore drilling must occur, is that no drilling below the threshold where oil is expected to be encountered should take place after April 15.

> "While drilling can be conducted year-round above a predetermined threshold depth, it should only be conducted below that depth during the frozen winter months, from November 1 through April 15. Confirmation, extension, and delineation drilling, well testing, and other well completion activities should be concluded by June 15. Finally, all nonessential vessel and air traffic associated with a drilling program should not occur in any particular area during the bowhead whale migration. These policies are reflected in out Land Management Regulations, Section 19.70.040." (NSB, 1991).

- Many NSB residents believe that public comments at public hearings and other public forums may be noted, but have little or no effect on project decisions or the overall direction and philosophy of the leasing program.

> Eben Hopson – Let me again repeat. We have told you why we don't want the lease sale. We have repeatedly told you why we don't want the lease sale. We have repeatedly told you for the whole week daily why we don't want a lease sale. The problem is you don't want to [?], you don't want to understand (ADNR, 1978).

> Joe Nukapigak – Sometimes our testimonies are just being–they're dissipate once we testify . . . . sometimes I feel that my comments are taken for granted, just to be pushed aside . . . . (USDOI, MMS, 1996a).

> Patsy Tukle, through Thomas Nupagiak as translator – He . . . it's hurt him. . . . Knowing that Inupiat doesn't have a written law, he hates you guys when you're coming with big books, tell us what to do. Even against the will of the people who talk, you still go ahead and do it anyway against the will of the people who talk, . . . the will of the Inupiat people . . . . You let us talk; you take our words back to you,

> and it just doesn't seem to show in your books that we have spoken (USDOI, MMS, 1996a).

- A general fear of cultural change, especially in terms of the loss of a subsistence lifestyle, which may lead to social disruptions or social problems in local communities (including youth becoming less interested in traditional ways).

> Mark Ahmakak – You wanted some comments on why we are opposing this State lease sale. Reason number one, is that this sale is very threatening to our very own lifestyle. Not only to the older people but also to the next generation. Not only on the basis of food which we live on which comes from the ocean, the land . . . . (ADNR, 1978).
>
> Edward Nukapigak – And I feel and strongly oppose this Pt. Thompson lease sale because oil companies don't have enough technology up to this date. Because its gonna really affect our lifestyle in the region of North Slope Alaska. Ever since I was about seven years old, that's when I started following my dad, how to hunt, how to fish. Might as well [inaudible or trails off] (ADNR, 1978).

- Oil development will result in an influx of population and other influences, which will disrupt and degrade Inupiat community life. In addition, oil development and its effects will impose additional demands upon Inupiat communities and individuals (and appearances at numerous hearings and the review of numerous documents is only the most visible of such demands).

> Mark Ahmakak – At this time and age, we're living in a combination of economic development and uses of the land (for) such (things) as hunting and fishing, subsistence life mixing with our cash economy system . . . I'd like to see all my kids grow up to be culturally tied to our native culture instead of completely giving in to the cash economy (Kruse et al., 1983b).

Comments reflecting all of these views are well represented in Volume II of the Final EIS for Lease Sale 144 (USDOI, MMS, 1996c).

Hope Basin

In terms of socioeconomic systems organization and issues, the Hope Basin area and the NSB share many characteristics (Burch, 1975, 1998; Cultural Dynamics, 1983; Kevin Waring Associates, 1992, 1988), although the subregions can be quite different in terms of environment and available resources. Giddings (1952, 1961, 1967) is a seminal source on the traditional arctic woodland culture of the Hope Basin region. Similarities with the North Slope include the continuing strong Native village identity of communities, the fundamental primacy of kinship as an organizing principal, and the imposition of a superstructure of "Western" institutions and forms. The Hope Basin area is organized into the NWAB. Its tax base is much more restricted than that of the NSB.

Norton Sound

The Norton Sound Planning Area is predominantly Eskimo. Villages from Unalakleet north are Inupiat Eskimo, and those south of Unalakleet are Yup'ik Eskimo. The villages of Savoonga and Gambell on St. Lawrence Island are Siberian Yup'ik. Within these areas, there is a variety of subgroups of Eskimos. All of them share similar characteristics; they are family oriented and have a kinship-based social structure. The family role is the dominant factor in an individual's behavior, and the family pattern is extended rather than nuclear. The people are oriented towards subsistence hunting and fishing, and many of the family-member functions are related to a subsistence way of life. In hearings for the Alaska Native Claims Settlement Act, Yup'ik Elder Paul John from the Native community of Tununak spoke this way about the Yup'ik subsistence lifestyle: "Our subsistence way of life is especially important to us. Among other needs, it is our greatest. We are desperate to keep it" (Fienup-Riordan, 1986).

The villages in the Norton Sound area generally have an "umealiq" or skinboat-captain structure for their marine-mammal-hunting crews—a structure which is pervasive throughout the organization of their society. In Nome and Unalakleet, there has been a higher degree of westernization than in the smaller villages (USDOI, MMS, 1985, 1990c, 1990d, 1990e; ADCED, 2000).

Cook Inlet

This subregion is quite diverse. Anchorage is the largest urban community in the State and is the major service center for the area. Most of the area is connected to Anchorage through a road network, and Anchorage is also the center of scheduled and charter aircraft. The Kenai-Soldotna area (i.e., Kenai, Soldotna, Nikiski, Sterling, Ridgeway, Kasilof) serves as a diversified service center for the central Kenai Peninsula area (Braund & Associates, 1980; Georgette, 1983). The Homer area serves as a smaller scale hub for the southern Kenai Peninsula. Small communities located in upper Cook Inlet that are not connected to the road network include Tyonek, Nanwalek, Port Graham, and Seldovia. All but Seldovia are predominantly Native with limited commercial economic opportunities, primarily related to fishing and fish processing. Subsistence activities are quite important and reinforce the fundamental kinship-based social organization of these communities (Braund & Associates, 1980; Reed, 1983).

Gulf of Alaska

The cultural history of the Gulf of Alaska prior to Euro-American contact is known primarily through oral traditions and archaeological data that indicate the region was the homeland of aboriginal people for thousands of years. The Alutiiq-speaking people who lived in Prince William Sound prior to Western contact were residents of various geographically based local groups (de Laguna, 1956), and Eyak-speaking people lived in various locations near the Copper River delta (Birket-Smith and de Laguna, 1938; Oswalt, 1967). During the contact period, the cultural boundaries in the Copper River/Controller Bay area fluctuated among various Eyak, Chugach, and Tlingit groups who inhabited the region (de Laguna, 1972, 1964, 1956; Johnson, 1984). Many current Native residents of the four modern Gulf of Alaska communities are descendants of these groups, although in-migration and intermarriage with Alaska Natives from other regions (and with non-Natives) have occurred. The western Gulf of Alaska is also culturally complex. Most Natives have a fundamental Aleut heritage and identity (IAI, 1982; USDOI, MMS, 1984b), but the Koniag heritage also remains important. Southeast Alaska Natives are Tlinget and Haida, and the boundaries between these groups were in dynamic change before and during the contact period with Euro-Americans.

The broad social patterns in place prior to European contact point to local group control and use of maritime and some terrestrial resources, supplemented by trade (de Laguna, 1956; Fitzhugh and Crowell, 1988). Russian contact and the fur trade greatly affected the Native populations and cultures of all parts of the Gulf of Alaska. Later, industrial developments (especially fishing) also greatly affected the size, composition, and distribution of the region's population. The non-Native population in the more accessible and economically diversified communities grew during the 20th century. During the same period, the predominantly Native villages maintained relatively small and homogeneous populations. Commercial fishing continues to be the dominant force in the Gulf of Alaska economy (USDOI, MMS, 1993), and also provides access to areas of Gulf of Alaska for subsistence resource use.

Contemporary communities in the Gulf of Alaska reflect considerable variety in social composition and cultural orientation, ranging from predominantly Native fishing villages to predominantly non-Native and generally larger and more diversified communities. Such communities generally contain relatively large Native populations and, in some cases, are in locations long occupied by Native people. The combination of Native and non-Native cultural elements is evident in many Gulf of Alaska communities, especially such western Gulf of Alaska communities as Sand Point and King Cove. Other fishing communities, such as the City of Kodiak and Petersburg, are predominantly non-Native both in composition and culture. Hub communities for the various parts of the Gulf of Alaska are predominantly non-Native in population, and relatively diverse in economic composition because of the presence of government offices and various support, service, and retail sectors.

3.2.3.5.2. Subsistence

The term "subsistence" has different definitions and meanings (Davidson, 1974; Arnold, 1978; Lewis, 1978; Lonner, 1980; Kelso, 1981, 1982; Case, 1984, 1989; Berger, 1985; Caulfield and Brelsford, 1991; Naiman, 1996; Loescher, 1999). All definitions of subsistence emerge from a complicated legislative and social history. The current Federal and State debate over the constitutional status of subsistence priorities notwithstanding, the ANILCA provides the operational basis for definition of the term subsistence in this document (even though it has been ruled to apply only to onshore Federal lands and waters in Alaska, and not to offshore waters). The analytical framework ANILCA constructs is the basis of all current documentation of Alaskan subsistence activity, both by the State and Federal Government. The dispute is not about what "subsistence activities" are, but rather (1) who qualifies as a "subsistence user" in terms of a priority for consumptive use of subsistence resources; and (2) to a lesser extent, which resources are "subsistence stocks." For the State, all Alaska residents are potentially qualified subsistence users; for the Federal Government, only rural Alaska residents are potentially qualified subsistence users. Areas of Alaska classified as "non-rural" include Anchorage, Fairbanks, Northstar Borough, the Juneau area, Valdez, the Ketchikan area, and the Wasilla area. Until very recently, portions of the Kenai Peninsula were also classified as "non-rural."

In addition to ANILCA, other legislative acts and regulatory actions relevant for the understanding of subsistence management issues on Federal lands include the Federal Subsistence Management Regulations (36 CFR 242 or 50 CFR 100; as summarized and available in USDOI, FWS [1999]), the Federal Advisory Committee Act, and the Federal Advisory Committee Management Regulations (41 CFR 101-6). The MMPA and ESA are also pertinent, addressing the harvest of marine mammals, which are currently restricted to subsistence use by coastal Natives.

The ANILCA explicitly recognizes that for rural Alaskans (Native and non-Native), "subsistence" subsumes a complex set of behaviors and values that extend far beyond the harvest and consumption of wild resources, although it is formally defined primarily in those terms. The current regulations define "subsistence use" as

> "… the customary and traditional uses by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools of transportation; for the making and selling of handicraft articles out of nonedible by-products of fish and wildlife resources taken for personal or family

consumption; for barter, or sharing for personal or family consumption; and for customary trade." (USDOI, Federal Subsistence Board [FSB], 1999)

Examples of subsistence resources potentially affected by OCS activities are marine mammals (bowhead and beluga whales, seals, walrus), fishes, and waterfowl. For some resources in certain areas, the FSB has determined that all rural Alaskan residents are qualified subsistence users. For other resources, the FSB has made more restrictive "customary and traditional" determinations of eligibility. To show customary and traditional use of a specific subsistence resource, a community or area is evaluated in terms of several factors. These include:

- time, depth, and consistency of its use;
- seasonal repetition of such use over many years;
- efficiency in terms of effort and cost of such use;
- consistency of the harvest or use of fish and wildlife in proximity to the community or area;
- historic or traditional means of handling, preparing, preserving, and storing fish and wildlife that have been used by past generations;
- intergenerational transmission of hunting and fishing skills, values, and knowledge;
- the sharing and distribution of the harvest;
- dependency upon a wide variety of fish and wildlife resources available in an area; and
- the provision of substantial cultural, economic, social, and nutritional elements to the community or area.

3.2.3.5.3. Sociocultural Significance of Subsistence

"Subsistence" as a label thus incorporates a complex set of behaviors and values that extends far beyond the harvesting and consumption of wild resources. Harvest and consumption are merely the most visible aspects of such a system, and the most logical entry point for examining a social system with a subsistence ideology. The fundamental values of such societies are expressed in the *idiom* of subsistence, so that kinship, sharing, and subsistence resource use behaviors (i.e., preparation, harvest, processing, consumption, celebration) become inseparable (Langdon and Worl, 1981; Elanna and Sherrod, 1984). Worl (1979) and Nelson (1979) describe subsistence as a central focus of North Slope personal and group cultural identity in addition to its primary economic role. Hopson (1976, 1978) establishes the political and ideological power of subsistence as an organizing concept for the NSB. The NSB currently is the most organized, strongest, and best-funded subsistence economy in Alaska. Simeone (1998) documents the central place subsistence has in village life and identity in Athabaskan communities. McNeary (1978) and North Pacific Rim (1981) describe the socioeconomic aspects of subsistence in the changing cultural landscape of the Prince William Sound region. In each region, communities express their unique identities based on their enduring connections between current residents, those who used the areas in the past, and the wild resources of the land. Elder's conferences, spirit camps, and other information exchange and gathering events serve to solidify these cultural connections between generations, and between the people and the land and its resources. This is not to say that all local subsistence economies are the same; however, the general values and central organizing concepts have many common threads.

Many studies have examined the relationship between subsistence and wage economies and how both subsistence and wage activities are integrated into rural Alaskan socioeconomic systems. General theoretical or conceptual treatments of these activities are available in Wolfe (1983), Wolfe et al. (1984), and IAI (1988). Although not always made explicit, it is recognized that all rural communities and rural socioeconomic systems are not the same. One salient variable is the ethnic composition of the community, while another is the diversification of the local economy and the availability of wage employment.

An extensive study series was conducted across a wide range of Alaskan communities during the 1980's that focused on local patterns of wild resource use as a component of the overall economy (Galginaitis et al., 1984; Reed, 1985; Sobelman, 1985; IAI, 1989; Stratton, 1989, 1990, 1992). Additional community-specific studies are cited in ADFG (1999). Some of these communities are predominantly Native, others are predominantly non-Native, while others are more ethnically "mixed." Some have developed wage (or self-employment) economies; others have few such opportunities. Within the NSB, both subsistence activities and wage economic opportunities are highly developed, and highly dependent upon each other (Kruse et al., 1981; Kruse, 1982, 1991; Harcharek, 1995; Shepro and Maas, 1999). Those communities most active in subsistence activities tend to be those who are also very involved in the wage economy. That is, monetary resources are needed to most effectively harvest subsistence resources, both as an individual (e.g., to purchase a boat, snow machine, four-wheeler, or all-terrain vehicle, fuel, guns and ammunition) or as the head of a collective crew (e.g., for whaling). There is evidence that Native subsistence users as a group display a different pattern of use than do non-Natives (e.g., use of different resource species, harvest and consumption of larger quantities, more widespread sharing and distribution of resources), as detailed in IAI (1988) and Human Relations Area Files (1994a,b, c).

Subsistence foods consist of a wide range of fish and game products that have substantial nutritional benefits. They are generally rich in nutrients and low in fats, and they contain more heart-healthy fats and less harmful fats than many non-Native foods (Nobmann, 1997). Subsistence foods also contribute to good health. Social, emotional, spiritual, and cultural benefits are other important aspects of subsistence food harvesting and sharing that contribute to personal and community health. Rural Alaskans harvest over 40 million pounds of wild foodstuffs every year (Wolfe, 1996). On average, food produced through hunting, fishing, and gathering amounts to just over one pound of wild food per person per day. Harvest data describe the amount of wild food available to a certain group of people, and are a rough estimate of what is eaten. Actual consumption varies from what is harvested or brought into the kitchen. However, few wild food consumption studies have been undertaken in Alaska.

According to 1990 estimates (Wolfe, 1996), the annual wild food harvest in rural Alaska was 375 pounds per person, compared to 22 pounds per person in urban Alaska. Assuming that, on average, 0.2 pounds of wild food contains 44 grams of protein, and 2.94 pounds of wild foods contains 2,400 kilocalories, the amount of wild food harvested in 1990 represented 243 percent of the rural population's protein requirements and 35 percent of the population's calorie requirement. In contrast, the food reportedly harvested by urban residents represented 15 percent of their protein requirements and 2 percent of their calorie requirements. Clearly, wild foods represent a major source of healthy foodstuff in rural Alaska.

3.2.3.5.4. Subsistence Activities

As discussed above, "subsistence" encompasses a wide-range of activities, and for some groups and individuals is a shorthand expression for the most central and important aspects of their lives. The most visible and easily documented component of this complex of subsistence activity is the actual harvest of subsistence resources. Broad regional discussions of selected aspects of subsistence resource harvest activities are provided below. Summary descriptive information for most regions and many communities within those regions is available (Schroeder et al., 1987a).

Beaufort and Chukchi Seas (North Slope Communities)

North Slope subsistence resource harvest activities have been relatively well documented, and the following discussions incorporate by reference the most pertinent agency information syntheses for recent Federal and State oil and gas lease sales and early planning efforts (USDOI, MMS, 1979a, b, c; 1982a, b, c; 1984a; 1987; 1990b; 1996a, b; 1997; USDOI, BLM, 1978; 1981; 1983a, b; Braund & Associates, 1997; State of Alaska, Department of Natural Resources, 1997, 1998, 1999; USDOI, BLM and MMS, 1998; USAED, 1999). These sources, for the most part, contain a regional overview as well as a discussion of relevant communities, with a presentation of more detailed information as required for the purposes of the specific document. Each is also supported by an extensive record of public hearing testimony as well as written comment.

Each North Slope community exhibits a unique pattern of subsistence resource use. Each village relies on a unique "mix" of subsistence resources, but caribou are harvested by residents of all North Slope communities, and are the most important terrestrial subsistence resource. Fish are also harvested by residents of all villages, and are a primary resource for all except Anaktuvuk Pass (which as an inland community has limited access to fish resources). Those communities that harvest whales, particularly bowhead whales, and other marine mammals (all but Anaktuvuk Pass and Atqasuk) also rely heavily on fish resources. Nuiqsut, Kaktovik, Barrow, and possibly Point Hope rely heavily upon and harvest all three animal resource categories – whales and other marine mammals, caribou, and fish. Anaktuvuk Pass relies primarily upon caribou, but receives a good amount of fish and whale through sharing and other modes of exchange. Residents of Anaktuvuk Pass and Atqasuk also receive whale through their participation as members of whaling crews in other communities.

Hope Basin

The subsistence use patterns for this area are generally similar to those of the North Slope, but there are several significant regional differences that create variations in emphasis to that general pattern. This area is richer in marine mammal resources other than bowhead whale than is the North Slope in general, and most communities rely heavily on this resource category (beluga, walrus, seal). Fish is also a consistently important resource category. One of these categories can comprise half or more of a community's subsistence harvest. Land mammals are the most variable resource category, which is related to the variable availability of caribou in the area. Information on the subsistence resource use patterns and quantitative harvest data can be found in the ADFG Subsistence Division community profiles database (ADFG, 1999), or in Saario and Kessel (1966) and Schroeder et al. (1987a,b) for more contextual detail.

Norton Sound

The Inupiat and Yup'ik Natives of the Norton Sound Planning Area depend on a local subsistence harvest of fish (80% in Kotlik), marine mammals (22% in Alakanuk), birds, whales, and other foods. Their language, culture, spiritual beliefs, customs, and values are all tied to an integrated, holistic view of the world centered on a traditional hunting, fishing, and gathering way of life associated with local subsistence resources. All Native residents of the area are dependent on subsistence resources.

There are four subsistence patterns in the region:

- a small-sea-mammal-hunting, inland-hunting-and-fishing pattern (in Shishmaref, Brevig Mission, Teller, and Mary's Igloo) where residents hunt (in order of preference) bearded, ringed, and spotted seals; walrus; waterfowl; fish; caribou (on the Seward Peninsula); and moose;

- a large-sea-mammal-hunting pattern (in Wales, Inalik [Little Diomede], Nome [King Island people], Gambell, and Savoonga [St. Lawrence Island]), which is predominantly oriented towards walrus and bowhead whaling (on St. Lawrence Island), as well as seals, fish (salmon and herring), and shellfish (king crab, clams and mussels);
- a Norton Sound fishing and coastal-and-inland-hunting pattern (in Solomon, Golovin, White Mountain, Council, Elim, Koyuk, Shaktoolik, Unalakleet), which is primarily oriented towards fishing, with salmon as the dominant species; however, the harvest of beluga whales, seals, moose (in Nome, Council, Solomon, and White Mountain) and caribou (in Shaktoolik, Unalakleet, and Koyuk) is also important; and
- a Yukon delta fishing and small-sea-mammal-hunting pattern (in St. Michael, Stebbins, Kotlik, Bill Moore's Slough, Hamilton, Emmonak, Alakanuk, and Sheldon Point [Nunam Iqua] (USDOI, MMS, 1985, 1990c, 1990d, 1990e; ADCED, 2000).

Herbert Anungazuk, a Native whaler from the community of Wales, explained the cultural importance of practicing a large-sea-mammal-hunting tradition, especially as it relates to the pursuit of the bowhead, at a 1993 symposium on Native whaling: "The desire to whale was instilled into us by our forefathers. It continues today, as it has for generations, and it cannot be destroyed by regulation from the outside world. It has always been regulated by the wind, the ocean currents, or ice conditions that are, and always shall be, the environment of the great whale. The spirit of our ancestors watches over us as we ply the waters in search of the whale" (Braham, 1995).

Cook Inlet

A discussion of subsistence in this region is relatively complex for a variety of reasons. The region includes the city of Anchorage, an urban area with 42 percent of the State's population. Anchorage is "nonrural," but its residents hunt and fish under "sport" regulations in other parts of the area, especially the Kenai Peninsula. Also, until recently, parts of the Kenai Peninsula itself were considered "nonrural." The FSB recently changed this, making the entire Kenai Peninsula "rural"; however, systematic resource use by the residents of a significant number of communities are lacking. Most of this area is connected by a road network, and most communities are of mixed ethnicity or predominantly non-Native. Four communities are not on the road network. Seldovia, a predominantly non-Native community, is on Seldovia Bay; itself located off Kachemak Bay, across from Homer. Port Graham and Nanwalek are predominantly Native communities located on the bays to the west of Seldovia Bay. Tyonek is a predominantly Native community on the upper northwest shore of Cook Inlet. These four communities, and especially the three predominantly Native villages, share many of the same characteristics of communities in the less economically developed parts of the State. Economic opportunities are relatively limited (other than commercial fishing), and subsistence resources are an important part of the household economy in terms of variety, amount, and sharing. Other road-connected communities of the region display somewhat different patterns of subsistence resource use (Georgette, 1983; Reed, 1983, 1985; ADFG, 1999).

A particularly sensitive issue is the subsistence use of beluga in Cook Inlet. Until recently, this was a relatively undocumented hunt, confined to Native subsistence users. Due to recent declines in their population, the Cook Inlet beluga whales have been classified as "depleted." Due to co-management agreements between NMFS and the Cook Inlet Marine Mammal Council (representing Native subsistence hunters) that limit future beluga harvests, this species has not been formally listed as threatened or endangered. Previous harvests were predominantly conducted by Natives living in or visiting Anchorage and residents of Tyonek. The current co-management agreement allows for the harvest of one beluga by the Tyonek community.

Gulf of Alaska

Throughout the 20th century, people have continued to harvest wild resources for trade and sustenance, adapting their harvests to the changing environmental and cultural conditions. Although the cultural matrix of subsistence has changed, the current residents of the Gulf of Alaska area, particularly communities with predominantly Native populations, continue to rely heavily on subsistence resources, especially fish, for their food. There are differences in the specific patterns of resource use within this broad area, and particularly between the three general divisions of western, central, and eastern Gulf of Alaska, but all are marine-oriented. The region also contains the "nonrural" communities of Valdez, Juneau, and Ketchikan. Although these are not "subsistence" communities, they also demonstrate a heavy use of "sport" and "personal use" caught fish. As is the case in many areas of Alaska, Gulf of Alaska residents participate in a mixed subsistence-cash economy; these two economies are especially intertwined for commercial and subsistence fishing (Wolfe and Bosworth, 1994). Subsistence foods provide Gulf of Alaska residents (particularly villagers) with some semblance of economic stability and a strong measure of cultural identity.

As is true in other regions, each community in the Gulf of Alaska has a unique resource harvest cycle. The annual harvest cycle fluctuates based on changes in resource availability, weather conditions, seasonal employment opportunities, and (in the smaller communities) the productivity of certain key harvesters. The one constant is the primacy of fish as a subsistence resource. Marine mammals tend to make up a larger part of the harvest in the western and central Gulf of Alaska than in the eastern Gulf of Alaska, because of resource availability and the ethnic composition of the populations of those areas. Deer are more important for eastern Gulf of Alaska communities because that is the limit of their range (although deer populations also exist on Kodiak, where they were introduced). For the Island of Kodiak, the smaller and predominantly Native villages are fairly similar in their patterns of subsistence resource use, and differ significantly from that of the City of Kodiak. The City of Kodiak is much larger, more ethnically diverse, and a much smaller percentage of its population is Native.

Salmon and other fishes (including halibut and herring) remain vital and generally available subsistence resources, and are taken in large quantities during the spring, summer, and fall by residents of all communities. The spring herring spawn (with roe on kelp and other delicacies) is particularly valued among villagers from Tatitlek and Chenega Bay. Marine mammal harvests have varied as their populations have fluctuated, but sea lions and harbor seals, when available, are taken opportunistically by Native villagers throughout the year. Deer and moose (where available) are hunted in the fall and winter. Waterfowl hunting primarily occurs in the fall, and black bear hunts occur in the spring and fall. Intensive shellfish harvests occur during the spring, and berry gathering is a fall activity. During the summer months, spirit camps at various locations have been instrumental as forums for regional Native youth to learn harvesting, processing, and traditional values from village elders (ADFG, 1999).

3.2.3.6. Environmental Justice

Environmental justice in the Alaska Region is centered around the possibility of disproportionate environmental and health impacts from oil and gas activity and how they may affect indigenous people. For example, if the harvest of bowhead whales or other subsistence resources are affected or are contaminated by oil and gas activities, this contamination could, in turn, affect the health of the Native people. Studies of indigenous people have been taking place in Alaska since the inception of MMS. In the Alaska Region, numerous social science studies have been conducted, most of which deal in some manner with Native people. Indigenous Inupiat, for example, have concerns and fears centered around the possibility that oil and gas development may displace subsistence resources, thus displacing their culture. To deal with these concerns, the MMS conducts studies along with public meetings to address real problems that people in Alaska, especially those in the NSB, face.

Whale hunting has always been and remains an important activity for Inupiat villagers residing along the Beaufort Sea. Archaeological evidence suggests bowhead whales were hunted and consumed by Okvik and old Bering Sea cultures some 2,000 years before present (Stoker and Krupnik, 1993), and by the Birnik peoples who settled in the area as early as 400 A.D. (Dumond, 1977). Evidence from the period beginning circa 1,000 A.D. indicates the bowhead was a primary food source for the Thule peoples. Whale hunting villages inhabited by proto-Inupiat speaking Thule were still thriving at the point of initial contact with Western explorers in 1826 (Sheehan, 1997).

New people brought new difficulties to Beaufort Sea communities already challenged by limited living resources and raw materials. Epidemics of disease and famine arrived with Yankee whalers in 1848, and commercial harvesting of whale and walrus populations led to diminished resources available for subsistence uses (Bockstoce, 1977). Trade economies and sociodemographic patterns were disrupted as coastal villagers began to trade with the Yankees rather than inland Inupiat who were, in turn, forced to migrate to coastal villages (Chance, 1960).

In a more contemporary sense, certain events and processes occurring since 1960 have furthered interactions between North Slope communities and broader social and economic influences. These include oil industry activities beginning in 1969, passage of the Alaska Native Claims Settlement Act in 1971, incorporation of the NSB in 1972, and construction of the TAPS during the mid-1970's. Native corporate investment in North Slope schools, health clinics, and other public projects was extensive in the 1980's, and State, national, and global economies and sociocultural processes continued to influence North Slope village life throughout the 1990's.

The post-contact Native history is, thus, one of ongoing encounters between a subsistence-oriented society and other material, political, and ideological agents of change. Of significance for current MMS research, such encounters always involve a conundrum of enabling and constraining factors and consequences. For instance, Yankee whaling gear simplified the whale hunt in the nineteenth century but also led to participation in a cash economy, at the partial expense of traditional subsistence practices and related social processes. Similarly, snowmobiles now increase physical interaction between Arctic villages, but they require fuel and replacement of parts, hence involvement in either wage or investment income-generating activities with all the consequences that involvement can entail (Anderson, et al. 1976, 1998). In this sense, as is the case for all U.S. citizens, North Slope villagers are at once affected by and involved in social and economic forces that ultimately bind them to the variable conditions of a wage economy in large part subsidized by oil and gas revenues.

As has been discussed, exogenous sociopolitical processes can affect village life in an invasive manner and can be a catalyst for social and economic change. Nonetheless, whale hunting remains an important focus of North Slope village life and the culture itself as it has for many centuries, and residents consider threats to whale populations and whale hunting a serious matter that could ultimately displace their culture and their subsistence way of life. This has lead to concerns and "risk perceptions" on the part of local communities. These concerns have been documented in the Liberty Development and Production Plan (USDOI, MMS, 2000, pp. III-C89) and through the use of "traditional knowledge".

Perceptions of Risk

Social effects can occur during any stage of the OCS oil and gas program. The MMS uses social science data and analysis in all phases of Agency decisionmaking, from 5-year planning through prelease and leasing activities, exploration, development, production, and platform decommissioning (Luton and Cluck, 2000). One of the less tangible areas of investigation centers around the "perceptions of risks" and general multidimensional attitudes towards the environment. Indeed, local concerns or NIMBY "Not In My Back Yard" responses (Smith, ongoing) pertaining to specific development projects can be very different than larger overarching worldviews or behavioral commitments relating to environmental issues (Cluck, 1998). However, in any case, if "perceptions of risks" exist, then they can have very real consequences and outcomes (Smith, USDOI, MMS, ongoing). These perceptions are inherent in industrial society through the understanding of science, progress, and democracy, and are reflexive in modernity itself. The epochal irritations such as air and water pollution, oil spills, and nuclear meltdowns aroused by industrial development are all the result not of the crisis but of the success of modernization. It is successful even against its own industrial assumptions and limitations. Reflexive modernization means not less but more modernity, a modernity radicalized against the paths and categories of the classical industrial setting (Beck, 1992, pp. 14). "Environmental problems are not problems of our surroundings, but in their origins and through their consequences are thoroughly social problems, *problems of people*, their history, their living conditions, their relations to the world and reality, their social, cultural and political situations" (Beck, 1992, pp.81). Ultimately, "the tangibility of need suppresses the perceptions of risks, but only the perception, not the reality or the effects, risks denied grow especially quickly and well" (Beck, 1992, pp. 45). Therefore, it is important to consider these perceptions from prelease to decommissioning in order to understand the relative and sometimes specific reflexivity of the particular people and "place" that may be affected. While it is apparent that "perceptions of risk" could not have been manifest without modernization at the macro level, the impacts from these perceptions must be discussed at a smaller level of aggregation, the community level. This allows MMS and decisionmakers to focus on specific impacts at local levels, address specific concerns, and conduct mitigation where appropriate.

3.2.3.7. Archaeological Resources

3.2.3.7.1. Prehistoric Resources

Offshore

At the height of the late Wisconsinan glacial advance (approximately 19,000 years ago) global (eustatic) sea level was approximately 120 m lower than present. During this time, large expanses of what is now the OCS were exposed as dry land. The exact elevation of past sea levels in relation to present sea level varies geographically, depending primarily on the location of the area in relation to the major late- Wisconsinan ice masses. This is referred to as relative sea level. There are no good relative sea-level data for the major portion of the Alaska OCS; however; relict fluvial channels and shoreline features evident at the seafloor suggest that sea level was probably between 50 and 60 m lower than present at 12,000 B.P. (Dixon, et al. 1986). Therefore, a conservative estimate of 60 meters below present is used for relative sea level at 12,000 B.P., the date at which prehistoric human populations could have been present in the area. The location of the 12,000 B.P. shoreline is roughly approximated by the 60-m bathymetric contour. The continental shelf shoreward of this contour would have potential for prehistoric sites dating subsequent to about 12,000 B.P.

Seismic and borehole data that have been collected in the Beaufort and Chukchi Seas indicate areas of well-preserved Holocene sedimentary sequences and landforms that have potential for containing prehistoric archaeological deposits. In the Beaufort Sea, remote sensing data from the Liberty, Warthog, and McCovey Prospects, landward of the barrier islands, indicate little evidence of ice gouging at the seafloor and areas of well preserved landforms such as river channels with levees and terraces just below the seafloor. Although these features have not been directly dated, their stratigraphic position indicates that they are most likely Holocene in age. The presence of these preserved landforms just beneath the seafloor indicates that there is also potential for preservation of prehistoric archaeological sites that may occur in association with the landforms. However, the potential for the occurrence of archaeological resources in the Beaufort Sea seaward of the barrier islands is probably much lower than for those areas landward of the barrier islands and in areas protected by floating, land-fast ice during the winter.

Analysis of shallow geologic cores obtained by the USGS in the northeastern Chukchi Sea indicate the presence of well-preserved coastal plain sedimentary sequences of Holocene age just beneath the seafloor (R.L. Phillips, written commun., USGS, Menlo Park, California, April 18, 1991). Radiocarbon dates on *in situ* freshwater peat contained within these deposits indicate that relative sea level in the Chukchi Sea area would have been approximately 50 m below present at approximately 11,300 B.P., the approximate date of the earliest known prehistoric human populations in the area. The location of the 11,300 B.P. shoreline is roughly approximated by the 50-m bathymetric contour. The continental shelf shoreward of this contour would have potential for prehistoric sites dating subsequent to approximately 11,300 B.P. The presence of preserved nonmarine Holocene sedimentary sequences in the Chukchi Sea indicates that there is also potential for preservation of prehistoric archaeological sites. Even in some areas of intense ice gouging, such as off Icy Cape, the Holocene sediments are thick enough that any archaeological sites that occurred in the underlying late Pleistocene deposits would be below the depth affected by ice gouging (see USDOI, MMS, 1990b).

Areas of the Alaskan OCS beyond the Beaufort and Chukchi Seas have not been subjected to the same level of geophysical surveying; therefore, there is little actual data on which to assess the potential for submerged prehistoric sites in these areas. However, an archaeological baseline study completed for the MMS by Dixon, et al. (1986) compiled available geologic, bathymetric, geophysical, climatic, and archaeological data in an effort to outline those areas of the Alaska OCS which may have the highest potential for preserved prehistoric archaeological sites. The primary indicators used to evaluate offshore prehistoric site potential were coastal geomorphic features onshore, relict geomorphic features offshore, and ecological data. It was proposed in the baseline study that these lines of evidence, taken together, indicate areas where subsistence resources used by prehistoric human populations would have been concentrated for sustained periods of time. The results of this study suggest that the nearshore areas of the Beaufort Sea, the area around Point Hope, the area around the Pribilof Islands, the area around Cape Newenham in the Bering Sea, the area around the Aleutian Islands, much of the Gulf of Alaska, Shelikof Strait, and parts of Cook Inlet all have potential for preserved prehistoric sites. However, actual geophysical data would be required to reconstruct the offshore paleogeography and determine specific areas where prehistoric archaeological sites may occur.

Onshore (Prehistoric/Historic)

Onshore archaeological resources near the Chukchi Sea coast receive less damage from the eroding shoreline than those on the Beaufort Sea coast, which is subjected to more slumping because of water action and permafrost. Therefore, known onshore archaeological resources exist in greater numbers; also, unknown resources are more likely to exist.

There are 200 to 300 known archaeological sites in the Hope Basin area. The area around Point Hope is especially rich in archaeological resources. The Bering Land Bridge National Preserve borders this section of the Hope Basin area.

The predominant prehistoric resources found on the shores near the Norton Basin area are house pits containing the household and subsistence artifacts of early people (stone lamps, sinkers, arrowheads, etc.). Historic artifacts found onshore near the planning area consist of old houses, roadway inns, fish camps, mining camps, and downed World War II aircraft.

On the Alaska Peninsula, one site has been listed on the National Register of Historic Places (ADNR, 1989—file no. XPM-001). Several areas on the Pacific Ocean and Bristol Bay coasts contain traditional hunting and fishing sites that are sources of valuable archaeological information. These are Simeonof Island, 11 sites; Stepovak Bay, 7 sites; Port Moller, 27 sites; False Pass, 25 sites; Cold Bay, 23 sites; Chignik, 27 sites; Sutwik, 3 sites; and Unimak Pass, 55 sites. The archaeological sites in the Port Moller area reveal prehistoric subsistence resources such as the remains of sea mammals, land animals, fishes, shells, sea urchins, and birds. These sites contain information on the wide variety of species used by ancient people. Over 75 known archaeological sites are listed for the Shumagin area. More detail on the region's cultural resources may be obtained from the Alaska Heritage Resources File (ADNR, 1989).

Research in the Kodiak Island area has revealed a succession of prehistoric maritime hunting and food-gathering cultures. The sequence can be outlined in phases from the oldest (8500 B.P.) to the youngest (650 B.P.) as Ocean Bay I, Ocean Bay II, Kachemak, and Koniag. During the *Exxon Valdez* cleanup effort, hundreds of archaeological sites were found, some dating before the historic period and some during that period. Oil-spill cleanup efforts during July 1989 uncovered a set of human bones on the north coast of Kodiak Island that are believed to date from at least the 1700's and perhaps before. The historic period of Kodiak began in 1874 when Gregor Shelekov founded the Russian fur post at Three Saints Bay. This was the first permanent Russian settlement in the New World, and it marked the beginning of a period in which there were great changes in relationships between the Russians and the Native Koniag Eskimos. Many historic sites and artifacts remain from this period.

Along the shoreline surrounding the Cook Inlet, the predominant types of prehistoric resources are housepits containing the household and subsistence artifacts (stone lamps, sinkers, arrowheads, etc.) of prehistoric people. Historic sites found onshore consist of early Russian houses, churches, roadway inns, fish camps, and mining camps.

Approximately 1,000 onshore archaeological sites in the Gulf of Alaska area have been listed on State records. Most of these sites lie next to the shore and consist of subsistence-resource-gathering sites, and many of them are listed on the National Register of Historic Places.

3.2.3.7.2. Historic Resources

Between 1851 and 1934, 34 shipwrecks occurred within a few miles of Barrow, and another 13 wrecks occurred to the west and east of Barrow in the waters of the Chukchi and Beaufort Seas. No surveys of these shipwrecks have been made; therefore, no exact locations are known. These wrecks would be valuable finds, providing us with information on past cultural norms and practices—particularly with regard to the whaling industry (Tornfelt and Burwell, 1992).

At Point Belcher near Wainwright, 30 ships were frozen in the ice in September 1871, and 13 others were lost in other incidents off Icy Cape and Point Franklin. Another seven wrecks occurred off Cape Lisburne and Point Hope. In the period from 1865 to 1876, 76 whaling vessels—an average of more than 6 per year—were lost because of ice and also because of raids by the *Shenandoah*, which burned 21 whaling ships near the Bering Strait during the Civil War (Bockstoce, 1977). The possibility exists that some of these shipwrecks have not been completely destroyed by ice and storms. The probabilities for preservation are particularly high around Point Franklin, Point Belcher, and Point Hope (Tornfelt and Burwell, 1992). A total of 21 shipwrecks have been documented in the Hope Basin area; 34 in the North Aleutian Basin area; 50 in the St. George Basin area; 110 in the Norton Basin area; 530 in the Gulf of Alaska; 41 in the Kodiak Island area lost between 1799 and 1937; 64 in the Cook Inlet area lost between 1829 to 1937; and at least 74 in the Shumagin area lost between 1893 and 1937 (Tornfelt and Burwell, 1992). With some exceptions, the sites of most of these shipwrecks are within State waters. However, the best-preserved shipwrecks are likely to be found on the OCS because wave action and ice are less likely to contribute to the breakup of ships in deeper waters.

A recent remote sensing survey in the Beaufort Sea recorded a large side-scan sonar target. The size and shape of this object and historical accounts suggest that it may be the crash site of the *Sigismund Levanevsky*, a Russian airplane that was lost during a transpolar flight in 1939 (Rozell, 2000). Subsequent attempts at groundtruthing this object have been unsuccessful in relocating the object and confirming its identity.

3.3. Pacific Region

3.3.1. Physical Environment

3.3.1.1. Meteorology and Air Quality

Climate

The climate of the coastal areas of Washington, Oregon, and California, is temperate with mild, wet winters and dry summers moderated by cool ocean breezes. In January, the average temperature ranges from around 5 °C (40 °F) along the Washington coast to about 12 °C (54 °F) around the southern California coast (USDOC, 1968). The average July temperature ranges from about 15 °C (60 °F) along the Pacific Northwest coast to near 21 °C (70 °F) in the Los Angeles area. The climate is very moist in Oregon, Washington, and northern California, while the southern California coast is semi-arid. For example, the average annual precipitation is about 240 cm (96 inches) along the Washington coast and around 30 cm (12 inches) in parts of the Los Angeles Basin.

During the winter season, Pacific storms dominate the weather in the Pacific Northwest and, on a less frequent basis, affect California. In late fall and winter, high pressure across the Great Basin periodically produces warm, dry Santa Ana winds over southern California. In the summer, the high pressure system in the eastern Pacific expands and moves northward, thereby becoming the dominant weather feature throughout the area. Precipitation is, therefore, inhibited and in California is almost entirely absent throughout the summer period. Due to coastal upwelling along the California coast, there are frequent occurrences of fog and low clouds.

On the open waters off Washington and Oregon, the most frequent wind directions measured by National Data Buoy Center buoys are between southeasterly and southwesterly, while winds between northwesterly and northeasterly directions are also common (USDOC, NOAA, 2001). The average wind speeds are between 4.5 and 5.5 m/sec (9 to 11 knots). The highest measured winds are about 21.5 m/sec (43 knots) with peak gusts of around 30 m/sec (60 knots). The variability of the winds reflects the frequent passage of Pacific storm systems. Nearshore winds are strongly influenced by coastal and topographic features especially in the Strait of Juan de Fuca and the Puget Sound.

Off the northern and central California coasts, the prevailing winds are northwesterly with average wind speeds between 6 and 7 m/sec (12 to 14 knots). The highest measured wind speed is about 22.5 m/sec (45 knots) with peak gusts of about 29 m/sec (58 knots). Off the southern California coast, the prevailing wind direction is westerly with an average speed of about 3.5 m/sec (7 knots).
In general, sea surface temperatures within the Pacific planning area are slightly higher than air temperatures. This would tend to result in slightly unstable atmospheres over water. Atmospheric stability provides a measure of the amount of vertical mixing of air pollutants. Dispersion of pollutants is favored when the atmosphere is unstable. However, off northern California and the Pacific Northwest, the sea surface temperature in the summer season is somewhat lower than the air temperature, which would tend to result in stable atmospheric conditions. The stable atmosphere would tend to limit mixing and dispersion.

Mixing height provides a measure of the depth of the lower atmosphere through which atmospheric pollutants are dispersed. The mixing height depends on heat flux (rate of warming of the surface layer) and wind speed. Over water, the air-sea temperature differences change slowly with time; thus, mixing heights are relatively constant. Over land, there is considerable diurnal variation with low mixing heights at night and high mixing heights associated with the daytime heating. During the summer, mixing heights along the coastal areas are reduced as a result of subsidence (sinking air motion) from the Pacific High as well as the relatively cool ocean temperatures due to upwelling. Furthermore, in the coastal valleys, and particularly in the Los Angeles Basin, topography and recirculation due to land/sea breeze effects inhibit atmospheric transport and dispersion . As a result, these areas tend to experience poor air quality when they contain significant population centers.

Air Quality

Air quality of the Washington and Oregon coastal counties is better than the national standards. Portions of the Seattle-Tacoma metropolitan areas in Washington are classified nonattainment for fine particulate matter (PM_{10}). However, no exceedances of the Federal standard were reported by monitoring stations during 1995 through 2000 (USEPA, 2001). The San Francisco Bay area is a moderate nonattainment area for ozone. In 1995 through 2000, the highest measured 1-hour average ozone concentration in the area was 0.16 ppm. The Federal ozone standard is 0.12 ppm for the 1-hour average. The South Coast Air Basin, which includes Los Angeles, is classified nonattainment for ozone, PM_{10}, and CO. The ozone nonattainment classification is in the extreme category. The highest measured 1-hour ozone concentration in Los Angeles County for 1995-2000 was 0.22 ppm. San Diego County is nonattainment for ozone and is classified serious. During this period, the highest measured 1-hour average O_3 concentrations were around 0.16 ppm.

3.3.1.2. Water Quality

Coastal water quality off the coasts of Washington and Oregon is very good, in part because of the limited number of sewage outfalls (and relatively low effluent volumes) found along the coast. While the plume from the Columbia River has been tracked as far north as the Strait of Juan de Fuca in winter and as far south as northern California in summer, its overall effects on water quality have been limited.

Off the northern California coast, factors affecting water quality include municipal sewage outfalls and riverine input. Marine and coastal water quality along the northern California coast is generally excellent (USDOI, MMS, 1996a), with select contaminants (e.g., heavy metals, petroleum, and chlorinated hydrocarbons) producing only localized degradation. Coastal and marine water quality off the central California coast is very good, with minor exceptions. Portions of Monterey Bay have degraded water quality as a result of sewage effluent and riverine input from several local rivers. Coastal and marine water quality off southern California is generally good, but, as with the central California coast, localized areas of water quality degradation exist due to high volume point sources (e.g., municipal wastewater outfalls in Los Angeles, Orange County, and San Diego), coupled with the combined effects of discharges from numerous small sources. Natural petroleum seeps are also recognized as significant sources of hydrocarbons in the Santa Barbara Channel area. Anderson et al. (1993) have detailed water quality impacts to the Southern California Bight region; the Southern California Water Research Project also has conducted annual sampling since the 1980's to assess water and sediment quality off southern California, with results presented in annual reports.

3.3.1.3. Acoustic Environment

Refer to section 3.1.1.5. for a general discussion of the underwater acoustic environment. Ambient noise levels in the Pacific Region can vary dramatically, depending upon proximity to major metropolitan areas, shipping traffic lanes, commercial fishing operations, and offshore oil and gas activities, as well as ambient oceanographic conditions and seafloor composition and topography. In busy port regions (e.g., Los Angeles/Long Beach, San Francisco, Seattle), shipping activities can contribute to ambient noise levels in the region, although such sources are transitory. In addition, commercial vessels and tankers moving up and down the U.S. West Coast also contribute noise to the marine environment. Shipping traffic is most significant at frequencies from 20 to 300 Hz (Richardson et al., 1995). Fishing vessels produce high frequency sound peaking at 300 Hz, whereas larger cargo vessels produce lower frequency sounds (Richardson et al., 1995). In the Santa Barbara Channel and Santa Maria Basin areas of southern and central California, oil and gas activities (including vessel and helicopter support operations) contribute to ambient noise levels on an intermittent or transitory basis. Offshore geophysical seismic surveys are another source of noise in the marine environment. Sounds produced by seismic pulses can be detected tens to hundreds of kilometers from the source (Greene and Richardson, 1988; Bowles et al., 1994). Marine mammals also can contribute significantly to the background noise levels. As noted in section 3.2.1.5, migrating gray whales produce knocks and pulses with frequencies from less than 100 Hz to 2 kHz, whereas humpbacks produce sounds between 20 and 2,000 Hz (Thompson et al., 1986). Fin whales typically produce calls around 20 Hz, which can be transmitted up to 185 km (Cummings and Thompson, 1971).

3.3.2. Biological Environment

3.3.2.1. Marine Mammals

Marine waters off the coasts of Washington, Oregon, and California are characterized by the presence of at least 34 different species of marine mammals, including cetaceans (whales, porpoises, dolphins), pinnipeds (seals, sea lions), and a single fissiped (sea otter). While some species are year-round residents, others occur as seasonal visitors. Marine mammal distributions off California have been summarized by Bonnell et al. (1981, 1983), Dohl et al. (1981, 1983), and Bonnell and Daily (1993). Similar summaries for marine mammals off Oregon and Washington have been prepared by Green et al. (1989, 1991).

3.3.2.1.1. Threatened or Endangered Species

Cetaceans

There are six listed cetacean species that may occur in nearshore or offshore waters of the Pacific Region, including the blue whale, fin whale, humpback whale, northern right whale, sei whale, and sperm whale. Overall descriptions for these species are in Section 3.2.2.1. Information specific to the Pacific Region is provided below. Current species status is provided in Table 3-31.

The eastern North Pacific stock of blue whale (*Balaenoptera musculus*) feeds in California waters from June through November and migrates south for the winter and spring months (Calambokidis et al., 1990; Mate et al., 1999). Ferrero et al. (2000) indicate that blue whales have increased in abundance in California waters, possibly the result of increased use of California as a feeding area. The best current estimate for the Eastern North Pacific stock of blue whale abundance is 1,940 individuals (Ferrero et al., 2000).

Recent observations show aggregations of fin whales (*Balaenoptera physalus*) year-round in southern/central California (Dohl et al., 1983; Barlow, 1997; Forney et al., 1995) and in summer in Oregon (Green et al., 1992; McDonald et al., 1994). Acoustic signals from fin whales are detected year-round off northern California, Oregon and Washington, with a concentration of vocal activity between September and February (Moore et al., 1998).

Winter/spring populations of humpback whales (*Megaptera novaeangliae*) in coastal Central America and Mexico, which migrate to the coast of California and southern British Columbia in summer/fall (Steiger et al., 1991, and Calambokidis et al., 1994) are referred to as the California/Oregon/Washington-Mexico stock. The most precise and least biased estimate of the California feeding stock is likely to be the mark-recapture estimate of 905 humpback whales for this population (Ferrero et al., 2000). Despite the apparently low proportion of calves produced in this stock, two independent lines of evidence indicate that the stock appears to be growing (Barlow, 1994; Calambokidis et al., 1999), with a best estimate of 8-percent growth per year (Calambokidis et al., 1999).

Sei whales (*Balaenoptera borealis*) are now rare in California waters (Dohl et al., 1983; Barlow, 1997; Forney et al., 1995; Mangels and Gerrodette, 1994), but they were the fourth most common whale taken by California coastal whalers in the 1950's-1960's (Rice, 1974). They are extremely rare south of California (Wade and Gerrodette, 1993; Lee, 1993). There are no abundance estimates for sei whales along the West Coast of the United States or in the eastern North Pacific.

Sperm whales (*Physeter macrocephalus*) are found year-round in California waters (Dohl et al., 1983; Barlow, 1995; Forney et al., 1995). They reach peak abundance from April through mid-June and from the end of August through mid-November (Rice, 1974). A recent survey designed specifically to investigate stock structure and abundance of sperm whales in the northeastern temperate Pacific revealed no apparent hiatus in distribution between the EEZ off California and areas farther west, out to Hawaii (Barlow and Taylor, 1998). The minimum population estimate for sperm whales, taken from summer/fall ship surveys off California, Oregon, and Washington (Barlow, 1997), is approximately 992 individuals.

Pinnipeds

There are two listed pinniped species found within waters of the Pacific Region: the Guadalupe fur seal and Steller sea lion. Current species status is provided in Table 3-31. Specific locations recognized as important congregation areas for pinnipeds in the Pacific Region include Grays Harbor and Willapa Bay (Washington), Cape Arago and the Columbia River mouth (Oregon), Cape Mendocino and Pt. St. George (northern California), Ano Nuevo Island and the Farallon Islands (central California), and the Channel Islands (southern California).

Guadalupe fur seals (*Arctocephalus townsendi*) were listed as threatened under ESA in 1985. Their range is from Baja California, Mexico, to southern California. Presence of this species in the Pacific Region is limited to occasional sightings on the Channel Islands (Stewart et al., 1987; Bonnell and Dailey, 1993), although strandings have been noted as far north as Sonoma County (Antonelis and Fiscus, 1980; Hanni et al., 1997).

Steller sea lions (*Eumetopias jubatus*) were listed as threatened under ESA in 1990. The Steller sea lions inhabiting the Pacific Region belong to the eastern U.S. stock (Loughlin, 1997). Limited information suggests that nonpup population counts have been relatively stable in California and Oregon since the 1980's (Ferrero et al., 2000). The NMFS aerial surveys and ground counts of California (2,042), Oregon (3,990), and Washington (523) rookeries and major haulout sites conducted in the summer of 1996 found a total of 6,555 Steller sea lion pups and nonpups (Ferrero et al., 2000).

Fissipeds

The species *Enhydra lutris* is found along the Washington coast between Pt. of Arches and Destruction Island (Bowlby et al., 1988), with limited sightings near Cape Flattery and Neah Bay, near the Strait of Juan de Fuca. The Washington population was established using translocated Alaskan sea otters and is not federally listed Along the California coast, this species extends from Ano Nuevo to the mouth of the Santa Maria River (USDOI, FWS, 1992). California or southern sea otters (*Enhydra lutris nereis*) were listed as threatened under ESA in 1977, because of their small numbers, limited distribution, and the increased risk of oil spills associated with oil development offshore California and with oil tankering from the TAPS at Valdez, Alaska, to ports in central California. In recent years, there have been increased sightings of sea otters further south, in the Pt. Conception region and Cojo Bay, at the westernmost end of the Santa Barbara Channel. Southern sea otter numbers have been in decline since 1995, although recent surveys (2000-2001) indicate that pupping numbers have increased. Sea otters also inhabit San Nicolas Island (an average of 20 individuals or fewer), off the southern California coast, as a result of a translocation effort implemented by the FWS between 1987 and 1990.

Sea otters prefer the shallow, nearshore waters overlying either a sandy or rocky seafloor. Preferred prey items include benthic macroinvertebrates. Over rocky areas, sea otters typically feed on abalone, crab, and sea urchins, while in sandy regions, this species is opportunistic, feeding on bivalves (clams, mussels, scallops), gastropods, echinoderms (sea stars, sea cucumbers), and octopus.

3.3.2.1.2. Nonendangered Species

There are approximately 25 nonendangered marine mammals species that may frequent waters of the Pacific Region, including beaked whales (*Ziphius*, *Mesoplodon*), pilot whales (*Globicephala*), pygmy sperm whales (*Kogia*), dolphins (*Delphinus*, *Grampus*, *Tursiops*, *Steno*, *Stenella*), and porpoise (*Phocoenoides*). Recent reference documents provide detailed descriptions of diet and feeding, distribution, and other life history information for these nonendangered marine mammal species (e.g., Bonnell and Dailey, 1993). All marine mammals are afforded protection under the MMPA. Harbor porpoises and harbor seals were detailed previously in Section 3.2.2.1. Select nonendangered marine mammal species are discussed below.

Cetaceans

The gray whale (*Eschrichtius robustus*) has shown strong signs of recovery and was delisted in 1994. Details of life history for this species were provided in Section 3.2.2.1. The eastern North Pacific stock undertakes one of the longest annual migrations of any marine mammal. They spend the summer feeding in the cold, arctic waters (Rice and Wolman, 1971), with reported feeding in waters off of southeast Alaska, British Columbia, Oregon, and Washington during summer. Gray whales migrate near shore along the coast of North America from Alaska to the California coast beginning in October or November (Rice and Wolman, 1971), typically with headland to headland movements that may bring individuals very close to shore. Winters are spent primarily along the west coast of Baja California, where pregnant females assemble in shallow lagoons to calve from January to mid-February (Rice et al., 1981). The northward migration begins in mid-February and continues through May, with cows and newborn calves typically migrating north between March and June (Rice et al., 1981). Gray whales may be present in the Pacific Region during these migration periods. Gray whales typically migrate, calve, and rear their young within a few miles of shore exposing them to the various human activities that tend to be concentrated near shore.

Subsistence hunters in Alaska and Russia have traditionally harvested gray whales from the eastern North Pacific stock. Approval was given in 1998 for Native Americans in Washington State to take five whales per year for subsistence purposes. The current IWC quota for subsistence takes is 620 animals for the 1998-2002 period (USDOC, NMFS, 2001). Mortality associated with commercial fishery operations is estimated at six whales per year (Ferrero et al. 2000). Ship strikes during coastal migration are estimated to kill one or two gray whales per year. Strandings have greatly increased in the last several years beginning in 1999, when 273 whales stranded along the west coast of North America from Baja California, Mexico to Alaska. The cause of the increase in gray whale stranding is not currently understood (Norman et al., 2000).

Killer whales (*Orcinus orca*) are common residents of the Pacific Northwest, where resident and migrant pods have been extensively studied. This species has been sighted occasionally in California waters, yet no resident populations have been noted in California waters (Forney et al., 1995); researchers suggest that killer whales sighted in California waters are travelling to or from pinniped rookeries offshore southern California or Mexico. The NMFS recognizes five killer whale stocks within the U.S. Pacific EEZ (Ferrero et al., 2000). Two of those stocks may occur off California. The Eastern North Pacific Transient stock occurs from Alaska through California. The Eastern North Pacific Offshore stock occurs from Southeast Alaska through California. A minimum abundance estimate for all killer whales along the coasts of California, Oregon, and Washington is 610 individuals, with 209 of those whales estimated to be from the offshore stock (Ferreo et al., 2000).

Pinnipeds

California sea lions *(Zalophus californianus)* range throughout the Pacific Region, from British Columbia to Mexico. Breeding occurs during the summer on islands off southern California (i.e., San Miguel, San Nicolas, San Clemente, and Santa Barbara islands) and Mexico. Based on census data collected in 1990, the majority of pups are born on San Miguel and San Nicolas Islands (Lowry et al., 1992). Most immature and adult males leave their breeding grounds in the fall, migrating northward to the Oregon, Washington, and British Columbia coasts. Peak migrations past central and northern California occur in September, with highest abundance levels seen off Oregon and Washington coasts in fall and winter. In California, this species is the most abundant pinniped on land and in continental shelf waters (USDOI, MMS, 1996a). The current minimum U.S. stock population estimate, based on the 1999 census, is 109,854 (Ferrero et al., 2000).

Northern elephant seals (*Mirounga angustirostris*) can be found at sea from Mexico to the Gulf of Alaska, with their present breeding range extending from Baja California to Pt. Reyes in northern California. Bonnell et al. (1983) and Hodder (1993) note that a limited number of pups have been born further north, at Point St. George (northern California) and Cape Arago (Oregon). Elephant seals have also been sighted in increasing numbers in Oregon and Washington, where they use select estuarine and coastal locations (Mate, 1977; Strickland and Chasan, 1989). This species typically remains at sea, returning to land only to breed and molt. Breeding occurs during the winter (December to March), with molting occurring in April-May or mid-summer. Bonnell and Dailey (1993) note that more than half of the northern elephant seal population is associated with rookery islands off southern California, including San Miguel, San Nicolas, Santa Barbara, and San Clemente Islands; other California rookeries include Cape San Martin (central California), Ano Nuevo Island, Southeast Farallon Island (northern California), and Pt. Reyes (northern California). Off Washington and Oregon, most elephant seal sightings have been noted over the shelf and slope, usually during summer (Bonnell et al., 1991). Off California, such sightings are predominantly in inshore waters, with only limited sightings beyond the continental slope (Bonnell and Dailey, 1993).

3.3.2.2. Marine and Coastal Birds

3.3.2.2.1. Threatened or Endangered Species

Six species of marine and coastal birds are listed as threatened or endangered for the Pacific Region: California least tern, California brown pelican, light-footed clapper rail, bald eagle, marbled murrelet, and western snowy plover.

California Least Tern (*Sterna antillarum browni*)

The California least tern is listed as endangered under the ESA. This species migrates from Central America in spring, establishing breeding colonies along the coast between Baja California and San Francisco. Preferring undisturbed sandy beaches or the shoreline of estuaries or lagoons, they currently restrict their presence in the Pacific Region, to southern, central, and portions of northern California. Foraging occurs in nearshore marine or estuarine waters, where least terns feed on small fishes (e.g., anchovies, topsmelt).

California Brown Pelican (*Pelecanus occidentalis californicus*)

The California brown pelican is listed as endangered under the ESA. This gregarious species ranges from British Columbia to southern Mexico; however, breeding and nesting sites are very restricted. U.S. west coast breeding sites for the brown pelican have recently been noted only on two of the Channel Islands off California (Anacapa Island, Santa Barbara Island). Off southern California, brown pelicans currently nest only at two sites, Anacapa and Santa Barbara Islands (Carter et al., 1992). The peak egg laying period occurs in March and April. The southern California population is estimated to be 6,500 breeding pairs (California Department of Fish and Game, 1997). Roosting sites extend along the entire California coast, with observations of pelicans over Oregon and Washington coastal waters. Most foraging (via diving) occurs in nearshore coastal waters (for commercially unimportant fish such as mullet, menhaden, herring, minnows, and silversides), within 11 km of the coast, although bird surveys have noted pelicans much further offshore (Briggs et al., 1987).

Light-footed Clapper Rail (*Rallus longirostris levipes*)

The light-footed clapper rail is listed as endangered under the ESA. This species, a coastal marsh inhabitant found exclusively in southern California and northern Baja California, has realized significant population decline in the past few decades. This decline, attributed to coastal development, has been noted primarily in large, tidal estuaries dominated by the salt marsh vegetation pickleweed (*Salicornia* spp.) and cordgrass (*Spartina foliosa*) (Baird, 1993). A total of 16 coastal marshes located between Carpinteria Marsh and Tijuana Estuary are considered to be primary nesting habitat (Zembal and Hoffman, 1999). This species feeds on a variety of marsh invertebrates, including crabs, crayfish, tadpoles, and insects.

Bald Eagle (*Haliaeetus leucocephalus*)

The bald eagle was reclassified from endangered to threatened throughout the lower contiguous United States in 1995. The USDOI, FWS, then proposed delisting the bald eagle in 1999. Bald eagles are long-lived. Life history and related information on bald eagles in Alaska was presented in Section 3.2.2.3.2. According to USDOI, MMS (1996), the current southern limit of the breeding range for this species is northern California, although nesting pairs have been observed in central California, in mainland southern California, and on Santa Catalina Island (Jurek, 1994). Migrating bald eagles leave the interior of Alaska in fall, heading south to nesting sites in British Columbia, Washington, and Oregon. In Washington and Oregon, nesting occurs primarily in the interior of the State (west of the Cascades) around Puget Sound or the Strait of Juan de Fuca, or along the Pacific coast. Among coastal nesting sites, the greatest nest concentrations are found on the Olympic Peninsula and within the Columbia River estuary. In California, nesting occurs primarily in mountains and foothills near water (e.g., lakes, rivers, reservoirs, etc.) of northern California. In 1998, the USDOI, FWS, estimated 630 breeding pairs in Washington, 324 in Oregon and 143 in California (Jodi Milar, USDOI, FWS, pers. commun., 2001). Most eagles nest within 0.8 km of water, the latter of which is a source of fish. Eagles also scavenge opportunistically, feeding on carrion of mammals and birds.

Marbled Murrelet (*Brachyramphus marmoratus*)

The marbled murrelet population of the Pacific Region (California, Oregon, Washington) was listed as threatened under the ESA in 1992. This species ranges from the Aleutian archipelago in Alaska, eastward to Cook Inlet, Kodiak Island, Kenai Peninsula, and Prince William Sound; and south along the coast to central California through the Alexander Archipelago of Alaska, British Columbia, Washington, and Oregon (Kessel and Gibson, 1978; Campbell, 1990; USDOI, FWS, 1992; Small, 1994). In California, the local distribution of this species is highly dependent upon the presence of suitable nesting habitat on shore–old growth coniferous forests. Similarly, their presence in coastal areas of the Pacific Region is closely tied to the presence of suitable nesting habitat. Murrelets primarily consume small schooling fishes, including Pacific sand lance, northern anchovy, Pacific herring, capelin, and microcrustaceans (i.e., euphausiids) (Burkett, 1995).

Western Snowy Plover (*Charadrius alexandrius nivosus*)

The western snowy plover was listed as threatened under the ESA in 1993. The Pacific coast population of this species, consisting of both resident and migratory individuals, typically breeds on coastal beaches from southern Washington to Baja California. Preferred nesting habitat consists of flat, open areas of sand along sand spits, dune-backed beaches, unvegetated beach strands, open areas around estuaries, and beaches at river mouths (Page and Stenzel, 1981).

3.3.2.2.2. Nonendangered Species

Seabirds

Seabird abundance estimates for the Pacific Region, estimated at 1.7 million breeding individuals, are considered to be modest when compared to numbers of seabirds found in Alaska (USDOI, MMS, 1996). Briggs et al. (1991) noted the highest concentrations of seabirds over the Washington and Oregon continental shelf, with a strong seasonal fluctuation in species composition (e.g., predominant summer species included shearwaters, storm-petrels, gulls, common murres, and Cassin's auklets; predominant fall species included gulls, phalaropes, fulmars, and California gulls). Major seabird colonies in the Pacific Northwest were noted on the Olympic Peninsula and in northern and southern Oregon. According to USDOI, MMS (1996), storm-petrels, shearwaters, and alcids are heavy users of the shelf-edge banks off northern Washington and central Oregon; shearwaters, gulls, murres, and auklets were commonly encountered over the broad shelf off Washington.

Briggs et al. (1987) have estimated that nearly 30 different species dominate offshore waters of California, where total abundance estimates may reach 4-6 million birds in coastal upwelling zones during fall and winter, as reported by USDOI, MMS (1996). Carter et al. (1992) estimated that 21 species were using nearly 500 breeding sites along the California coast, with common murres representing the dominant species. Central California waters and the Southern California Bight (SCB) represent major coastal and offshore regions for seabirds (Baird, 1993). In central California, major breeding populations for murres were noted at Pt. St. George and on the Farallon Islands. All seabirds breeding in the SCB, with the exception of terns and skimmers, use the Channel Islands. Further details regarding seabirds and their use of the marine environment can be found in Briggs et al. (1987), Hunt et al. (1981), and Baird (1993), among others.

Shorebirds

Shorebirds are normally defined as a group whose members exclusively use shorelines of the open coast and offshore rocks, as well as protected shores of wetlands, estuaries, bays, and lagoons. Plovers, sandpipers, and avocets are considered typical shorebird families. Species that are characteristic of sandy beaches include plovers (black-bellied, semipalmated), willets, whimbrels, marbled godwits, sanderlings, and sandpipers (least, western). Species using rocky shorelines or offshore rocks include oystercatchers, turnstones (black, ruddy), spotted sandpipers, and surfbirds. The majority of shorebirds that frequent the coasts and shorelines of the Pacific Region have migrated from Alaska. Details of shorebird breeding in Alaska have been presented in Section 3.2.2.3.2. Shorebirds begin their southward migration from Alaska between August and October, reflecting species-specific dispersal patterns, to wintering areas in California, Mexico, and Central and South America. Shorebird migration occurs in steps, or stages, where certain staging areas are used for a short period of time (for resting and feeding) before the next migratory step. Important staging areas of the Pacific Region include Puget Sound and Gray's Harbor in Washington and Humboldt and San Francisco Bays in northern California.

3.3.2.3. Fish Resources

Fish resources of the Pacific Region have been characterized as complex, dynamic, and extremely rich, with more than 600 species of fishes present as either resident or migrant populations. Large numbers of shellfish and other invertebrate species also occur in this area, with the most important being crabs, shrimp, bivalves, abalone, sea urchins, and squid. This high level of diversity is reflective of the complex chemical, physical, and geologic conditions of the region that interact to provide a wide variety of habitats for fishes. Greatest fish diversity is seen in southern California waters, where more than 550 species have been noted (Cross and Allen, 1993; Miller and Lea, 1972). Moving northward, species diversity decreases with roughly 500 species attributed to the central California area, 485 species noted in northern California, and 400 species off the Oregon and Washington coasts (USDOI, MMS, 1996). Fishes can be classified according to life habits or preferred habitat, as detailed below.

Anadromous Fishes

Five species of salmon (*Oncorhynchus* spp.) use nearshore and offshore waters, as well as spawning streams inshore of the Pacific Region. Chinook and coho salmon are the predominant species caught and managed under the Pacific Fishery Management Council (PFMC) salmon management plan. Sockeye, chum, and steelhead are only rarely caught in the PFMC ocean fisheries. The abundance of salmon is influenced by numerous natural and manmade phenomena and is highly variable. Distribution and life history information of Pacific salmon are detailed in Hart (1973).

Steelhead trout (*Oncorhynchus mykiss*) are anadromous fish that primarily use streams from central California to the Bering Sea for spawning. Important spawning streams occur in Washington, Oregon, and northern California (Barnhart, 1986; Pauley et al., 1986). There are both winter and summer spawning races of steelhead. Winter run steelhead migrate and spawn in their natal streams from November to April, while summer run steelhead migrate upstream from May through October. The abundance of steelhead in Washington and Oregon has declined due to excessive sportfishing pressure and habitat loss and/or degradation (Pauley et al., 1986). Population declines in California are attributed primarily to loss of freshwater and estuarine habitat, and to increased mortality of smolts from such activities as dam construction and operations, water diversion, and sport fishing activities (Barnhart, 1986).

Tag recapture data showed that steelhead originating from streams in the Pacific Region may migrate as far north as southeast Alaska and along the Aleutian chain, before returning to their natal streams to spawn (Pauley et al., 1986). Limited information on steelhead that inhabit Cook Inlet shows the population to be unevenly distributed throughout. Most data were collected from sport fishermen during years of high population abundance.

Soft-Bottom and Hard-Bottom Fishes

Common fish species occurring over soft-bottom benthos include skates and rays, smelts, surfperches, and flatfishes; however, other species may predominate in certain areas (e.g., white croaker, hagfish, ratfish). In the SCB, approximately 40 percent of the species and 50 percent of the families of fishes occur in soft-bottom areas of the open coast (Cross and Allen, 1993). Hard substrates are one of the least abundant benthic habitats, yet they are among the most important habitats for fishes. Typical shallow water (< 50 m), hard-bottom fishes include rockfish (e.g., *Sebastes* spp.), lingcod, and sculpins; deeper reefs are dominated by large, mobile, nektobenthic species (rockfish, sablefish, Pacific hake, spotted ratfish, and spiny dogfish). According to Cross and Allen (1993), approximately 30 percent of the species and 40 percent of families of fishes in the SCB occur on hard substrates. With more than 125 fish species identified in association with hard-bottom (rocky reef) features in the SCB, only 50-60 species are considered common, and only 15-20 species are abundant (Cross and Allen, 1993).

Coastal Pelagic Fishes

Coastal pelagic species are schooling fishes, not associated with the ocean bottom, that migrate in coastal waters. In December 1998, the Coastal Pelagic Species Fishery Management Plan was approved, including management provisions for Pacific sardine (*Sardinops sagax*), Pacific (chub) mackerel (*Scomber japonicus*), northern anchovy (*Engraulis mordax*), jack mackerel (*Trachurus symmetricus*), and market squid (*Loligo opalescens*). On December 15, 1999, regulations to implement the fishery management plan for coastal pelagics were formally adopted (Southwest Fishery Management Council [SWFMC], 2000).

Epipelagic Fishes

Epipelagic fishes include small schooling herbivores (e.g., northern anchovy, Pacific sardine, Pacific mackerel), schooling predators (e.g., Pacific bonito, yellowtail), and large solitary predators (e.g., sharks, swordfish) (Cross and Allen, 1993). Many of these species are commercially harvested. With the exception of several subtropical species, most epipelagic fishes have extensive ranges that cover most of the Pacific Region.

Midwater Fishes

Midwater (or mesopelagic) fishes are pelagic species that inhabit water depths ranging between 50 and 600+ m. In southern California waters, there are approximately 120 species of midwater fishes, with only a few being of commercial importance (Cross and Allen, 1993).

Demersal Fishes

The SWFMC has identified 83 species that typically live on or near the bottom of the ocean; thus, the terms “groundfish” or “bottomfish” are often used to describe them. Species groups include rockfish (55 species), flatfish (12 species), sharks and skates, groundfish, and others. Some important groundfish species include Pacific whiting or hake, sablefish, and lingcod (SWFMC, 2000).

Highly Migratory Fishes

Highly migratory species in the Pacific Ocean include tunas, swordfish, marlins, sailfish, oceanic sharks, and others. These species are harvested by U.S. commercial and recreational fisheries and by foreign fishing fleets. Only a fraction of the total harvest is taken within U.S. waters. The Western Pacific Regional Fishery Management Council developed the Fishery Management Plan for Pelagic Fisheries of the Western Pacific Region, which was implemented in 1987. The Pacific and North Pacific Councils have not yet developed plans for these species (SWFMC, 2000).

3.3.2.4. Sea Turtles (Threatened or Endangered)

Four species of sea turtles, the leatherback, green, Pacific ridley, and loggerhead are known to frequent waters of the Pacific Region, although their presence in these waters has been categorized as uncommon. All four are listed as either endangered or threatened species under the ESA. There are no designated critical habitats or migratory routes for sea turtles in the Pacific Region. There is no sea turtle nesting on the U.S. west coast.

Leatherback Sea Turtle (*Dermochelys coriacea*)

The endangered leatherback sea turtle ranges further north into the cooler waters of the eastern Pacific Ocean than any of the other sea turtle species, with sightings as far north as Alaska (Mager, 1985). This species was the most commonly sighted during MMS-sponsored surveys off California (Center for Marine Studies, 1983) and Washington and Oregon (Green et al., 1989). Most sightings of this species have occurred in deeper shelf and slope waters. The primary threat to the leatherback in U.S. coastal waters is incidental take by fisheries while engaged in pelagic foraging.

Green Sea Turtle (*Chelonia mydas*)

The threatened, east Pacific population of the green sea turtle, when present, is found in the southernmost portion of the Pacific Region, although stranded individuals have been noted as far north as Washington (and one stranded turtle reported as far north as Homer, Alaska) (USDOC, NMFS, and USDOI, FWS, 1998a). This is perhaps the most commonly observed turtle on the Pacific Coast of America. A small resident population of 30 – 50 individuals can be found in the warm water effluents of San Diego Bay, California. Mager (1985) suggests that nesting occurs further south, in Mexico and along the Central American coast, in warmer, subtropical regions.

Pacific Ridley Sea Turtle (*Lepidochelys olivacea*)

The endangered Pacific ridley sea turtle is the smallest of the Pacific sea turtle species. Pacific ridleys nest along the Pacific coast of Mexico and south to Columbia. While sightings of this species in the Pacific Region are uncommon, strandings data have been noted for Washington and Oregon and northern California (Smith and Houck, 1984; Green et al., 1991). Recent investigations show that ridleys reside in oceanic habitats of the eastern Pacific Ocean during the nonreproductive portion of their life cycle (USDOC, NMFS, and USDOI, FWS, 1998b). The primary threats to ridleys in U.S. waters are entanglement in debris and boat collisions.

Loggerhead Sea Turtle (*Caretta caretta*)

The threatened loggerhead sea turtle inhabits subtropical to temperate waters worldwide, preferring continental shelf waters. Loggerheads nest along the Central and South American coasts. In the eastern Pacific, loggerheads are reported as far north as Alaska and as far south as Chile. Occasional sightings are also reported from the coast of Washington; however, most records are of juveniles off the coast of California (USDOC, NMFS, and USDOI, FWS, 1998c). The Center for Marine Studies (1983) considered them rare visitors to waters of the Pacific Region.

3.3.2.5. Coastal Habitats

3.3.2.5.1. Wetlands and Estuaries

Wetland and estuarine habitats along the Pacific coast consist of salt marshes, eel grass beds, fresh and brackish water marshes, and mudflats. Wetland habitats may occupy only narrow bands along the shore, or they may cover larger expanses at the mouths of bays, rivers, or coastal streams. Estuaries are important habitat for both resident and transitory species, providing spawning or nursery habitat and foraging area for numerous species, including invertebrates, fishes, reptiles, birds, and mammals. Both estuaries and wetlands are characterized by high organic productivity, high detritus production, and extensive nutrient recycling.

Estuaries contain a greater diversity of both plant and animal life forms per unit surface area than any other habitat in the marine environment. Estuaries are highly productive because they constitute an area where freshwater, marine, and terrestrial habitats meet and intermingle. High levels of nutrient input from terrestrial sources, high levels of freshwater input from streams, high levels of marine-origin nutrient input caused by tidal flushing, shallow depths, and high heat retention are also factors supporting the greater productivity of estuaries. Because of their extremely high rate of biological productivity (Odum, 1959), estuaries are frequented by numerous species (transients) at various times. Some species spawn in estuaries, and their young reside there before venturing out to sea. The young of other species, although spawned in the ocean, use estuaries for nursery habitats. On a daily or tidal-cycle basis, many species enter estuaries to feed.

Estuaries are important habitats for both resident and transient species. Species found in estuaries belong to almost every major plant and animal taxonomic group. Many birds are dependent upon these highly productive areas for all or most of their life cycles. Some vegetation, such as cordgrass (*Spartina* sp.), pickleweed (*Salicornia* sp.), and eel grass (*Zostera* sp.) occur almost exclusively in estuaries and form salt marshes and eel-grass beds, which are some of the most productive habitats known in nature. The mudflats are rich in invertebrates, including clams, which are important to sport fishermen. Fish and mobile invertebrates occur in the channels as well as over mudflats.

Along the coasts of Washington and Oregon, estuaries are typically larger than those found further south. Important estuaries in this portion of the Pacific Region, in decreasing order based on size, include Puget Sound (526,110 ha), Willapa Bay (14,084 ha), the Columbia River estuary (6,070 ha), Coos Bay (3,845 ha), Tillamook Bay (3561 ha), Umpqua-Winchester Bay (2,308 ha), and Grays Harbor (2,873 ha).

In northern and central California, estuaries provide spawning and nursery habitat for marine fish and invertebrates, and roosting and foraging areas for migrant and resident birds. Major estuaries in this portion of the Pacific Region include San Francisco Bay, Elkhorn Slough, Bodega Bay, Tomales Bay, Bolinas Lagoon, Humboldt Bay, Eel River, Lake Earl, and Smith River (USDOI, MMS, 1996).

Major estuaries in southern California have realized significant degradation and loss over the past several decades, primarily as a result of upland and coastal development, channel dredging, and other development activities. At present, major estuaries in this portion of the Pacific Region include Mugu Lagoon, the Santa Maria and Santa Ynez River mouths, Anaheim Bay, upper Newport Bay, Goleta Slough, Carpinteria Marsh, and the Tijuana Estuary.

3.3.2.5.2. Intertidal Benthos

The two most prominent beach types found in the Pacific Region are rocky shores and sandy beaches, the latter of which are most common in this region. By their nature, sandy beaches are less stable environments than rocky shores, given the potential for seasonal changes in beach profile associated with wind and wave exposure and the effects of nearshore currents. Rocky shore habitats are more abundant from southern Oregon to central California, and along the Channel Islands offshore southern California

The rocky shore intertidal substrate forms a solid platform on which algae and invertebrates attach and obtain a firm hold against the forces of waves, wind, and currents. A myriad of usually smaller invertebrates live within the cover and protection provided by the larger attached (sessile) plants and animals. During high tide, while the intertidal is covered with water, fish feed on the productive intertidal community. At low tide, birds are known to feed on certain invertebrates, and, in some areas, particularly the southern California mainland, intertidal species are exposed to human trampling, collecting, storm-water runoff, and other human-induced impacts.

Descriptions of rocky intertidal communities and species on the west coast of the United States are extensive (e.g., Carefoot, 1977; Oceanic Institute of Washington, 1977; Power, 1980; Dawson and Foster, 1982; USDOI, MMS, 1983, 1984c, 1987; Ricketts et al., 1985; Strickland and Chasan, 1989; Murray and Bray, 1993; Thompson et al., 1993; Niesen, 1994). Some of the communities on the rocky shore are very long-lived (tens of years) and are very diverse in species. For example, the *Mytilus* or mussel community, the *Endocladia* community (a red algal community), and the *Pelvetia* or rockweed community are all examples of long-lived, diverse communities. Although their distribution may be patchy, mussels often are found covering broad expanses of the rocky intertidal habitat of central and northern California (Ricketts et al., 1985). The *Mytilus* community is generally very species rich and often multilayered, up to 20 cm thick (Kanter, 1980). Another rocky intertidal community is dominated by the surfgrass *Phyllospadix*. This community occurs in the lower intertidal to subtidal areas and supports a major nursery habitat for a wide variety of fishes and invertebrates. Each of the previously described seaweeds and invertebrates are critical sources of biogenic structure in their respective zones.

Factors that influence the distribution, abundance, and species composition of rocky intertidal shores may be divided into two categories, physical factors and biological factors. Major physical factors include exposure to the air, impact of waves, substrate composition, texture and slope of substrate, water temperature, and the previously described human-induced factors. Important biological factors include competition and predation. In general, the upper vertical limits of rocky shore communities are determined by physical conditions, while the lower vertical limits are controlled by biological factors (Carefoot, 1977).

A conspicuous and widely recognized feature of rocky shores is zonation, although zonation is not obviously present on all shorelines. Intertidal zonation has been well studied in several areas, and a number of descriptive systems have been proposed for classifying habitats and summarizing their populations. Several of these systems are discussed in detail in Oceanic Institute of Washington (1977). Stephenson and Stephenson (1949, 1972) have summarized universal or widespread features of zonation that are reflected in the zonal patterns of rocky shores found within the Pacific Region. Generally, the upper area contains some species that appear to be transitional between land and sea forms. These organisms can survive neither completely on land nor completely at sea. The upper intertidal grades into the lower intertidal, which has more and more species occupying more and more of the available space until, somewhere around mid-level and below, every conceivable space is inhabited by algae or invertebrates.

In general, intertidal communities on the islands and mainland coast located away from major metropolitan areas appear to be less altered than those intertidal areas near cities (Littler, 1980). Several species appear to be reduced everywhere except at rare locations which are largely inaccessible to human collecting.

Since the mid-1980's, the black abalone (*Haliotis cracherodii*) population on the California Channel Islands and along the mainland in central California has undergone major declines in abundance due to a fatal disease referred to as withering foot syndrome. (Haaker et al., 1992; Steinbeck et al., 1992). Scientists have determined that withering foot syndrome is caused by a bacterial infection. This bacterial species, which thrives in warmer ocean waters, causes the abalone’s foot to shrink and the animal to lose its hold on the rock (Lafferty and Kurtis, 1993). Significant reductions have been recorded since 1985 on the islands and from Government Pt. to Pt. Arguello in central California since 1992. (Engle et al., 1998). Current populations of abalone along the central California mainland are 5-10 percent of the 1992 baseline (Raimondi et al., 1999), and are below 1 percent of the 1985 baseline population of abalone on the Channel Islands (Richards and Lerma, 2000). A few young abalone were observed during fall 2000 on the Channel Islands, but it is too early to determine whether these are disease resistant (Richards, oral commun., 2000). Researchers with the California Department of Fish and Game have produced disease resistant animals in the lab; outplanting of these animals is considered possible if the population does not make a comeback naturally.

A number of accounts describe the general environment and ecological nature of sandy beaches (Hedgpeth, 1957; Oceanic Institute of Washington, 1977; Power, 1980; USDOI, MMS, 1983, 1984c, 1987b; Ricketts et al., 1985; Strickland and Chasan, 1989; Thompson et al., 1993; Niesen, 1994). The sandy intertidal habitat type is a much less stable environment than the rocky shore type due to the continual shifting of sand by wind, wave, and current actions. The biotic component of sandy intertidal habitats is made up almost exclusively of animal species. Permanent sandy beach residents include crustaceans, polychaete worms, and mollusks. Other animals that may also be found include grunion, moon snails, crabs, shrimps, and echinoderms. Generally, the only flora to be found in this habitat are diatoms and other microscopic species and bacteria associated with organic detritus in the sand. Although less obvious than the floral component of the rocky intertidal habitat, the sandy beach flora constitute a major food base for the numerous minute animals that inhabit the interstitial spaces between sand grains (see Swedmark, 1964; and Hulings and Gray, 1971, for detailed information on interstitial sandy beach meiofauna).

3.3.2.6. Areas of Special Concern

3.3.2.6.1. Essential Fish Habitat

The PFMC manages 90 species of fish under three FMP's: Coastal Pelagics FMP, Pacific Groundfish FMP, and Pacific Salmon FMP. Section 3.1.2.8.1. defines and discusses EFH. The EFH has been established for five species of coastal pelagics: Pacific sardine (*Sardinops sagax*), Pacific (chub) mackerel (*Scomber japonicus*), northern anchovy (*Engraulis mordax*), jack mackerel (*Trachurus symmetricus*), and market squid (*Loligo opalescens*). The EFH has also been established for 83 species of groundfish (USDOC, NMFS, 1998). The FMP groups the various groundfish EFH descriptions into seven units called "composite EFH's," taking a whole ecosystem approach. These seven composites include estuarine, rocky shelf, nonrocky shelf, canyon, continental slope/basin, neritic zone, and the oceanic zone. The EFH's for coastal pelagic fishes and groundfish extends from the coast out to the edge of the EEZ between the U.S-Canada and U.S.-Mexico borders. The EFH also includes surface waters (i.e., waters above the thermocline) where sea-surface temperatures range between 10^{o} C and 26^{o} C. The EFH for groundfishes includes both surface waters and benthos, extending from the mean high tide line or upriver extent of saltwater intrusion (in river mouths) seaward to the edge of the EEZ (U.S. Department of Defense, Department of the Navy, 2000).

The EFH has been established for five species of salmon: chinook (*Oncorhynchus tshawytscha),* coho (*Oncorhynchus kisutch),* chum *(Oncorhynchus keta),* pink (*Oncorhynchus gorbuscha),* and sockeye (*Oncorhynchus nerka*). The EFH for Pacific salmon include those waters and substrate necessary for salmon production to support a long-term sustainable salmon fishery. The EFH includes all streams, lakes, ponds, wetlands, and other currently viable water bodies and most of the habitat historically accessible to salmon in Washington, Oregon, Idaho, and California. In the estuarine and marine areas, salmon EFH extends from the nearshore and tidal submerged environments within State territorial waters out to the full extent of the EEZ (370.4 km) offshore Washington, Oregon, and California north of Point Conception.

Habitat Areas of Particular Concern

Habitat areas of particular concern exist for three species of salmon. The HAPC for chinook and coho salmon include plane-bed, pool-riffle, and forced-pool riffle stream channels, which are channel types less than 4-percent slope (Montgomery and Buffington, 1997; Montgomery et al., in prep.). Pink salmon enter fresh water primarily to spawn, and juveniles spend little to no time in fresh water. Therefore, freshwater spawning and juvenile rearing areas, including estuarine and nearshore locations such as Puget Sound and other inland marine waters of Washington State and British Columbia, are critical to the early marine survival of pink salmon.

3.3.2.6.2. Sanctuaries, National Parks, Reserves, and Refuges

Sanctuaries, parks, reserves, and refuges are legally defined areas regulated by either the Federal or State governments with the primary intent of protecting marine resources for the inherent biological or ecological value. A listing of these protected areas found along the California coast is provided in Table 3-32.

Marine Sanctuaries

There are five prominent national marine sanctuaries in the Pacific Region, extending from the northwestern tip of Washington State to southern California, as detailed below.

- Olympic Coast National Marine Sanctuary–Designated in 1994, this sanctuary consists of 8,577 km^2 of nearshore and offshore waters along the northwestern portion of the Washington coast, from the U.S.-Canada border south to Koitlah Point, including coastal marine waters from shore to the 100-fathom isobath. Important habitats found within this sanctuary include offshore islands and rocks, kelp beds, rocky intertidal and headlands, sea stacks and arches, exposed beaches and protected bays, submarine canyons and ridges, and the continental shelf and slope. Prominent biological components of this sanctuary include 27 species of marine mammals (resident or migratory species), a reintroduced population of sea otters, and one of the largest seabird colonies in the continental United States (USDOI, MMS, 1996a).
- Cordell Bank National Marine Sanctuary–Designated in 1989, this sanctuary consists of 1,362 km^2 of offshore waters located 80 km northwest of San Francisco. The sanctuary boundaries encompass Cordell Bank and lie in close proximity to the Gulf of the Farallones National Marine Sanctuary. Cordell Bank, the northernmost seamount on the California continental shelf, and surrounding waters of the sanctuary provide habitat for more than a dozen listed species, several protected marine mammals, and seabirds (USDOI, MMS, 1996a).
- Gulf of the Farallones National Marine Sanctuary–Designated in 1981, this sanctuary consists of 3,252 km^2 of nearshore and offshore waters located north and south of the Reyes Headlands, between Bodega Head and Rocky Pt. and the Farallon Islands. According to USDOI, MMS (1996a), the sanctuary provides habitat for one of the largest and most diverse seabird and pinniped populations in the eastern Pacific Ocean.
- Monterey Bay National Marine Sanctuary–Designated in 1992, this sanctuary consists of 13,802 km^2 of nearshore and offshore waters of Monterey Bay, including Monterey Canyon. The sanctuary provides habitat for a diverse assemblage of cetaceans, pinnipeds, sea otters, fishes, and seabirds, attributed to the unique submarine topography and enhanced productivity of the Bay.
- Channel Islands National Marine Sanctuary–Designated in 1980, this sanctuary consists of 4,296 km^2 of nearshore and offshore waters surrounding five of the Channel Islands (San Miguel, Santa Rosa, Santa Cruz, Anacapa, and Santa Barbara). The sanctuary boundaries extend from the islands' mean high tide lines seaward 11.1 km. The sanctuary provides habitat for at least 32 marine mammal species (e.g., minke, gray, and pilot whales; northern fur seals; California sea

lions; dolphins; and porpoises) and breeding seabirds, including nesting sites for the endangered brown pelican.

National Parks

National parks have been established to protect the natural scenic, wildlife, marine, ecological, cultural, and scientific value of the resources found within a park's boundaries. The Pacific Region contains three national parks that border the marine environment–one in Washington and two in California.

- Olympic National Park (Washington) – Established in 1938, this park extends along 80 km of exposed coastline between Cape Flattery and the mouth of the Queets River.
- Redwood National Park (northern California) – Established in 1938, this park extends along 50 km of exposed shoreline between Crescent City and Stone Lagoon.
- Channel Islands National Park (southern California) – Established in 1938, this park is composed of four of the northern Channel Islands (San Miguel, Santa Rosa, Santa Cruz, Anacapa) and Santa Barbara Island.

National Estuarine Research Reserves

National Estuarine Research Reserves have been established to provide long term protection to vital habitats for estuarine-dependent species. Single National Estuarine Research Reserves have been founded in Washington (Padilla Bay National Estuarine Research Reserve) and Oregon (South Slough National Estuarine Research Reserve, Coos Bay estuary), and two have been established in California (Elkhorn Slough National Estuarine Research Reserve, near Monterey; Tijuana River National Estuarine Research Reserve, near San Diego).

National Wildlife Refuges

National wildlife refuges in coastal Washington include Flattery Rocks, Quillayute Needles, and Willapa Bay, while the Oregon coast includes Cape Meares and Oregon Islands National Wildlife Refuges. Along the California coast, wildlife refuges include Humboldt Bay, Salinas River, Seal Beach, and Tijuana Slough. National wildlife refuges provide protection to listed and protected species, migratory waterfowl, and resident and transitory shorebirds (USDOI, MMS, 1996a).

Areas of Special Biological Concern

While there are no designated ecological reserves, marine life refuges, or areas of special biological significance along the coasts of Washington and Oregon, these States have led efforts to recognize select areas because of their biological importance. Such recognition includes establishment of recreation areas (e.g., Oregon Dunes National Recreation Area), national parks, National Estuarine Research Reserves, and National Wildlife Refuges, as cited previously.

The State of California has established select coastal sites of biological importance as Marine Protected Areas, in recognition that such sites represent areas of special concern. Four separate designations are employed by the State of California:

- areas of special biological significance,
- ecological reserves,

- marine life refuges, and
- reserves and preserves**.**

3.3.3. Socioeconomic Environment

3.3.3.1. Fisheries

Commercial Fisheries

Major commercial fisheries are located in Washington and Oregon, operating from the ports within Puget Sound, Grays Harbor, Willapa Bay, Astoria, Newport, and Coos Bay. Of prominent importance are commercial fishing operations targeting five different species of salmon, albacore tuna, sablefish, Pacific whiting, rockfishes, Pacific cod, Pacific halibut, rex and petrale sole, and several invertebrate species (Dungeness crab, oysters, scallops, clams). The data presented below can be found in USDOC, NMFS (2000a).

In Washington, during 1999 the commercial fisheries having the greater metric tonnages were Pacific hake (20,059,352 t), Dungeness crab (19,026,006 t), and Pacific oyster (7,045,058 t). The species that brought the greater dollar amounts were Dungeness crab ($39,550,093), Pacific oyster ($19,646,538), and Pacific geoduck clam ($16,531,732).

In Oregon during 1999, the commercial fisheries having the greater metric tonnages were Pacific hake (160,964,614 t), ocean shrimp (20,451,242 t), and Dungeness crab (12,347,135 t). The species that brought the greater dollar amounts were Dungeness crab ($23,107,231), ocean shrimp ($9,570,825), and sablefish ($7,764,242).

In northern California, commercial fishing operations are based in Crescent City, Eureka, and Fort Bragg, with smaller operations in a variety of other ports. Important commercial fisheries in this part of the Pacific Region include Dungeness crab, dover sole, rockfishes, chinook salmon, sablefish, shrimp, albacore, petrale and English sole, rex sole, and Pacific whiting. Along the central California coast, major commercial fishing operations are conducted from San Francisco and surrounding coastal communities, Bodega Bay, Tomales Bay, Moss Landing, Santa Cruz, and Monterey. Target species in this portion of the Pacific Region include northern anchovy, flatfish, rockfishes, albacore, salmon, Dungeness crab, shrimp, sablefish, squid, and various shellfish species.

In southern California, major commercial fishing operations are conducted from Los Angeles-Long Beach, San Pedro, Santa Barbara, Oxnard, Ventura, Port Hueneme, Morro Bay, Port San Luis, and Avila Beach. Target species in this area include rockfishes, sole, ocean shrimp, spotted prawn, sablefish, halibut, salmon, albacore, rock crab, swordfish, pelagic shark, and market squid.

In California during 1999, the commercial fisheries having the greater metric tonnages were market squid (91,518.7 t), kelp seaweed (173,983,500 t), and Pacific sardines (59,471 t). The species that brought the greater dollar amounts were market squid ($33,276,814), Dungeness crab ($17,156,125), and sea urchins ($13,428,884).

Recreational Fisheries

Washington, Oregon, and northern California generally have comparable levels of public participation in recreational fishing activities. Sportfishing is an important recreational activity throughout central California, while southern California is considered a focal point for marine sport fishing in the eastern Pacific (USDOI, MMS, 1996a). These activities are detailed in USDOI, BLM (1980) and USDOC, NOAA (1986).

More than 165 fish species have been noted in the sport catch for southern California, however, only a few of the species made up most of the catch. Recreational fishermen target several pelagic, reef - associated, and demersal fishes; details are provided in USDOI, MMS (1996). Additional information on recreational fisheries in southern California is summarized in Cross and Allen (1993).

During 1999, the top three species of fish recreationally caught and kept in northern California were blue rockfish, black rockfish, and jacksmelt. In southern California, the top three species caught and kept were barred sandbass, chub (Pacific) mackerel, and Pacific barracuda. In Oregon, the three species most frequently caught and kept were black rockfish, blue rockfish and canary rockfish. In Washington, the three species most frequently caught were surf smelt, Pacific herring, and black rockfish.

3.3.3.2. Tourism and Recreation

Recreation and tourism are two primary components of the Pacific Region's socioeconomic and sociocultural fabric. Recreational activities conducted in the coastal zone include sightseeing, camping, clam digging, hiking, biking, beachcombing, picnicking, boating, swimming, diving, wading, sunbathing, surfing, and sportfishing. Many of the national parks, reserves, sanctuaries, State parks, and marine protected areas noted in Section 3.3.2.6.2. are preferred destinations for residents and visitors. Tourism activities represent an important revenue source to local and State economies. Recreational activities depend upon an accessible and unpolluted marine environment. Most of these activities occur at established shoreline park, recreation, beach, or public access sites. Other recreational activities closely associated with the coastal and offshore environment of the region are water-enhanced; that is, the ocean provides a setting that enhances the enjoyment of activities. The most intense use of available recreational resources is generally found near the major coastal population centers.

Recreational boating is an especially important activity for both Oregon and Washington. It is estimated that 25 percent of Oregon's population participates in some form of boating activity. Approximately 10 percent of the users are from out of State. Water-dependent marine recreation along the California coast includes such activities as boating, fishing, whale watching, diving, skin diving, surfing, and wind surfing. These activities tend to occur near established shoreline parks, beaches, recreational sites, and public access areas. Recreational use along the beaches of southern California is the most intense of all areas on the West Coast. Santa Monica Bay has the highest frequency of use, with beach attendance exceeding 75 million per year. Other areas of high use are the Orange County and the San Diego beaches, with combined attendance of over 50 million per year.

Tourism is one of the major industries in California and has been an important element in the regional economy. Tourism has been defined by the California Office of Tourism as "nonroutine visits to an area for pleasure, business, meetings, or other purpose." This means that any trip of a nonroutine nature will be included in the total value of the tourist industry, as opposed to only the vacation/pleasure trips that are considered the more traditional tourist forms.

California's coastline is an outstanding visual resource of great variety, grandeur, contrast, and beauty and contributes to the economic success of the tourist industry. Most of the coastal region is a highly sensitive natural resource area and is an important recreational asset to the residents.

Water-dependent marine recreation includes such activities as boating, fishing, surfing, swimming, and diving. Each of these recreational activities is dependent upon an accessible and unpolluted marine environment. Most of these activities occur near established shoreline park, recreation, beach, and public-access sites. Sightseeing and beachcombing are enjoyed along the entire coast and are mainly dependent on the aesthetic aspect of the coastline and ocean view.

3.3.3.3. Sociocultural Systems

The demography, employment, income, and land-use characteristics of the coastal communities of the Pacific Region are extremely diverse and varied. The rural, generally undeveloped, segments of the Pacific Northwest and northern California coastline are predominantly characterized by small communities that rely, variably, on the timber and fishing industries, as well as recreation and tourism. Exceptions to this characterization rest with the metropolitan areas of Seattle, Portland, and San Francisco. While these cities are located off the open coast, they all represent busy ports, with waterborne commerce an important aspect of their economies. The northern portions of the Pacific Region lie in stark contrast to the largely urban environment of coastal southern California, where (with minor exception) communities stretch almost continuously from 50 km north of Los Angeles to San Diego. The large metropolitan areas of the Pacific Region represent destinations of opportunity for many individuals, as evidenced by the diverse racial and cultural composition (e.g., Caucasian, Hispanic, African-American, Asian, Pacific Islander, Native American, etc.) of the region's major cities (U.S. Census Bureau, 2001a).

In the Pacific Region, Native American subsistence gathering, although not previously well documented, may involve several thousand individuals and can account for a major portion of the total subsistence for some Native American families (USDOI, BLM, 1980b). In an effort to document this sociocultural system, MMS funded a study titled "*Potential Effects of OCS Oil and Gas Activities on Oregon and Washington Indian Tribes.*" This study provides an in-depth analysis of the traditional and contemporary subsistence gathering and hunting activities in the Pacific Northwest by the Chelalis, Chinook, Makah, Quileute, Quinault, Tilamooke, Clallam, Lummi, Samish and Snohomish tribes. (BarBh et. al., 1991).

Subsistence gathering along the Washington and Oregon coasts involves both foodstuff and traditional medicines, such as herbs and teas. The taking of salmon and shellfish make up the largest portion of the subsistence economy in the area. Historically, the types of resources taken have been very extensive and have included salmon, skate, mussels, cod, sculpins, porpoise, seal, halibut, deer, elk, duck, geese, herring, sturgeon, gulls, puffins, crabs, cormorants, roots, berries, and eels. Currently, the types of resources taken are far fewer than was common in historic times; however, subsistence gathering is an extremely important part of life for the contemporary Indian tribes in Oregon and Washington. Ocean resources are also used in an extensive barter system, exchanging salmon and other ocean resources for inland resources (deer and elk, etc.). The resources are also sold for cash as a means of supplementing their income (USDOI, MMS, 1987b).

A primary example of an ocean-dependent society is the Makah tribe of Washington's Olympic Peninsula, whose tradition of whale hunting has existed for the last 1,500 years. In addition to subsistence benefits, whale hunting and its associated activities fulfill an important ceremonial and social function for the Makah. Whaling was so important to the Makah that they explicitly secured their rights to continue whaling in the Treaty of Neah Bay, entered into with the U.S. Government in 1855 (USDOC, NMFS, 2001).

Historically, the Makah continued to conduct tribal whaling during the 19th and early portions of the 20th century, targeting both gray and humpback whales. After the 1920's, a number of external factors led to the decline of tribal whaling (e.g., failure of the U.S. Government to provide assistance for whaling, epidemics, drastic declines in the eastern North Pacific gray whale population). The Makah took their last gray whale in the pre-modern era in 1928 (Rice and Wolman, 1971). In May 1995, after the eastern North Pacific gray whale had been removed from the Federal list of endangered and threatened species, the Makah informed NOAA that it wanted to resume ceremonial and subsistence whaling. According to the Makah, its cultural and subsistence needs include a harvest of up to five whales a year, the ability to hunt whales safely using traditional methods, and the ability to practice the ceremonial aspects of whaling. Further information regarding the Makah tradition of whaling can be found in Renker (1997) and USDOC, NMFS (2001).

The NMFS is currently re-evaluating the environmental consequences of allocating any gray whales to the Makah Tribe for the years 2001 and 2002. It is the objective of NMFS to accommodate federal trust responsibilities and treaty whaling rights to the fullest extent possible, by fulfilling the Makah's cultural and subsistence needs, while ensuring that any tribal whaling activity does not threaten the eastern North Pacific gray whale population (USDOC, NMFS, 2001).

In California, gathering for subsistence and ceremonial purposes has been primarily documented by BLM and others. The distribution of the subsistence and hunting activities in California varies. In northern California, activities tend to be very similar to those occurring in Oregon and Washington, while in Southern California, the intertidal zone is the object of intensive gathering activities by members of various ethnic groups. The traditional Native American gathering in southern California has been reduced in recent years because of a decrease in the supply of traditional plant and animal foods (USDOI, MMS, 1987b). Nevertheless, the Chumash people or more accurately the Santa Ynez Band of California Mission Indians are currently involved in "government to government" meetings both at Federal and State levels. The objectives of the meetings are to determine if offshore development projects impact a natural resource that is culturally important to the tribe.

These traditional practices are dynamic and take place and manifest themselves among more modern ones. Indeed, it is important to suggest that the beach, the coast, and the ocean itself exist as important geographic, spiritual, and socially constructed components for many Pacific coast residence. The beach, the coast, and the ocean provide substantial income generation for the local economies from recreation and tourism along with accompanying ocean-related indirect industries. However, the beach, the coast, and the ocean are more than merely a use of lands, they provide a certain "coastal connection" between residence and the sea (see Molotch, 1998). There are use values as well as nonuse values that take place among coastal inhabitants, in turn shaping perceptions of the beach, the coast, and the sea. Varying social groups "connect" to the coastal waters in different ways, from fishermen to surfers to subsistence users to nonuse residents. How these perceptions play out is largely a process of sociocultural systems involving use and nonuse values that have been socially framed and reframed over time.

3.3.3.4. Archaeological Resources

3.3.3.4.1. Prehistoric Resources

Offshore

The MMS has conducted two archaeological baseline studies that cover the entire Pacific Region. These studies include the California, Oregon, and Washington Archaeological Resource Study

(Espey, Huston & Associates, Inc., 1990), which ran from Morro Bay, California, north to the Canadian border; and the Archaeological Resource Study: Morro Bay to Mexican Border (PS Associates, 1987). These studies compiled existing information on relative sea-level change and the late Pleistocene/Holocene geology of the Pacific continental shelf in order to determine what areas would have potential for the occurrence of submerged prehistoric archaeological sites.

The relative sea-level history of the Pacific OCS is very complex due to its active tectonic history and the great variation in isostatic response across the region as the late Wisconsinan ice masses melted. Those portions of the continental shelf that were exposed as dry land at any given point in time would have potential for prehistoric archaeological sites. However, archaeological sites would tend to concentrate in association with landforms that concentrated basic subsistence resources such as fresh water and food resources. Such landforms include streams, ponds, lakes, embayments, and lagoons.

Previous research has already located several inundated prehistoric sites and artifacts offshore California including inundated shell middens (Nelson, 1909; Bickel, 1978; Masters, 1983), campsites (Muche, 1978 and 1982), and ground stone artifacts (Hudson, 1976 and 1977; Masters, 1983). The ground stone artifacts recorded by Masters are indicative of the Milling Stone Cultural Horizon (La Jollan; ca. 9000 to 3000 B.P) in southern California.

Onshore (Prehistoric/Historic)

The onshore coastal areas of the Pacific Region contain numerous prehistoric and historic archaeological sites. Many of these sites are the cultural remains of early coastal Native American populations. The baseline study for northern California, Washington, and Oregon compiled information on 2,762 known prehistoric archaeological sites within a narrow strip of land along the coast. The baseline study for southern California documented 1,681 known prehistoric archaeological sites along the coastal area south of Morro Bay to the Mexican border. The total of 4,443 prehistoric archaeological sites along the Pacific coast represents only those sites that have been recorded to date. It is likely that there are thousands of additional undocumented sites. The presence of La Jollan cultural remains on the Channel Islands is evidence that these people (ca. 9000 to 3000 B.P.) possessed seafaring watercraft.

3.3.3.4.2. Historic Resources

The MMS archaeological baseline study for northern California, Oregon, and Washington identified a total of 3,850 shipwrecks for the area from Morro Bay north to the Canadian border. The baseline study for southern California identified a total of 916 shipwrecks for the area from Morro Bay south to the Mexican border. The total of 4,766 shipwrecks recorded for the Pacific Region represents only those shipwrecks that have been documented through literature searches.

Most of the shipwrecks are located close to shore at harbor, bay, or river mouths. The locations of historic shipwrecks often are not extremely accurate, due to the normally violent circumstances under which they occurred and the state of the art in navigation at the time of the loss.

4. ENVIRONMENTAL CONSEQUENCES

4. ENVIRONMENTAL CONSEQUENCES

4.1. Assessment of Programmatic Concerns

4.1.1. Department of Defense Use Areas

Airspace over the Gulf of Mexico is used by both the U.S. Air Force and the U.S. Navy for various rocket launches and system tests, as well as for pilot and flight crew training. Much of the Eastern Gulf of Mexico Planning Area has been designated as operating areas of various types.

Military activities in Gulf of Mexico waters have been summarized in U.S. Department of Interior (USDOI), Minerals Mangement Service (MMS) (1997a, 1998, 2000b). These activities normally consist of various air-to-air, air-to-surface, and surface-to-surface fleet-training and air forces exercises. The Navy uses the Gulf for shakedown cruises on newly built ships, and for ships completing overhaul or extensive repairs in Gulf shipyards such as those located in Pascagoula, Mississippi. No aircraft carriers are currently stationed in the Gulf, but carriers may from time to time conduct flight operations there. Of the 17 Military Warning Areas in the northern Gulf of Mexico area, seven are designated by the U.S. Air Force for the conduct of various testing and training missions, and 10 are designated by the Navy for various naval training and testing operations. The U.S. Air Force operations are controlled out of the Eglin Military Air Force Base (located in northwest Florida) and through Air National Guard offices (located in Corpus Christi and Houston, Texas; and Gulfport, Mississippi). Naval operations are controlled and coordinated through facilities in Key West (Florida), Corpus Christi (Texas), and New Orleans (Louisiana). Live ordnance air-to-surface training is currently accomplished on the land ranges administered by the Eglin Military Complex; at present, the U.S. Air Force is attempting to reopen the offshore ranges for high explosive gunnery training. If approved, it is estimated that 14 missions per year will be required to accomplish the required over-water, air-to-surface gunnery and test operations (USDOI, MMS, 1998).

Although offshore oil and gas activities have the potential to affect military activities, the U.S. Department of Defense (USDOD) and the USDOI have cooperated on these issues for many years and have developed mitigation measures that minimize such conflicts. For example, stipulations are applied to oil and gas leases in critical military use areas. Whenever possible, close coordination between oil and gas operators and the military authorities for specific operational areas is encouraged and, in some cases, is required under these lease stipulations. In some instances where the military requires unimpeded access to specific areas on the Outer Continental Shelf (OCS), specific lease blocks have been deleted from one or more proposed lease sales.

The greatest potential conflict with military activities appears within the Western Gulf of Mexico Planning Area, based on the number of lease sales expected and the current use of the area by the Navy. The USDOI will continue to coordinate with USDOD regarding future lease offerings, new areas of industry interest, and current or proposed areas of military operations. As part of this coordination, applicable stipulations would continue to be routinely evaluated and modified, as necessary, to minimize or eliminate conflicts. The Eastern Gulf of Mexico Planning Area also has a potential for conflicts. Intensive use of the planning area by the Air Force and the Navy tends to limit where oil and gas operations may take place without very close cooperation between USDOI and USDOD. Oil and gas operations in some areas could severely restrict USDOD activities because of the danger to personnel and equipment. In some past cases, areas of intensive USDOD use have been deferred from leasing, and others are leased but operations take place on the leases only during specified periods. The USDOD has not requested that any blocks in the Eastern Gulf of Mexico program area be deferred from this 5-year program. Impacts to USDOD activities from oil and gas operations, or impacts on exploration and development from USDOD activities will be minimized through the use of the mitigation measures developed in the past.

Offshore oil and gas development within the Alaska Region would not interfere with standard or routine military practices. Additional vessel traffic resulting from industry development and exploration would simply increase existing traffic, and not impact military activities. The MMS works in cooperation with the U.S. Coast Guard regarding industry exploration and development in waters off the coast of Alaska.

4.1.2. Global Climate Change

4.1.2.1. Background

The surface temperature of the earth is increased because of the presence in the air of gases that absorb infrared (IR) radiation. The IR active gases (i.e., primarily water vapor, carbon dioxide [CO_2] and ozone) that are naturally present in the earth's atmosphere absorb thermal IR radiation emitted by the earth's surface and atmosphere. This warms the atmosphere, which in turn emits IR radiation; a substantial portion of this energy warms the earth's surface and lower atmosphere. This mechanism is termed the "greenhouse effect", and the IR active gases responsible for the effect are termed "greenhouse gases." The rapid increase in concentrations of greenhouse gases in the earth's atmosphere since industrialization has caused concerns over potential changes in the global climate. The primary anthropogenic greenhouse gases are CO_2, methane (CH_4), nitrous oxides (N_2O), and halocarbons. There is also evidence to suggest that global background values of ozone are increasing due to emissions of nitrogen oxides (NO_x), carbon monoxide (CO), CH_4, and volatile organic compounds (VOC).

The atmospheric concentration of CO_2 is presently about 370 parts per million (ppm), which is an increase of 31 percent since 1750. The current rate of increase of CO_2 is about 1.5 ppm (0.4%) per year (Intergovernmental Panel on Climate Change [IPCC], 2001a). About 75 percent of the anthropogenic CO_2 emissions are attributed to fossil fuel burning; the remainder is predominantly due to land use changes, especially deforestation. The level of CO_2 in the atmosphere is determined by a complex cycle that involves the exchange of carbon between the atmosphere, the biosphere, and the oceans. It is estimated that the oceans and terrestrial biota absorb about half of the CO_2 emissions, while the rest accumulates in the atmosphere (IPCC, 2001a).

Currently, the atmospheric concentration of CH_4 is about 1.75 ppm. This value is 2.5 times the 0.7 ppm concentration that prevailed around the year 1750 (IPCC, 2001a). A major portion of CH_4 emissions is from fossil fuels, cattle, rice agriculture, and landfills. Concentrations of N_2O have risen from about 270 parts per billion (ppb) in the pre-industrial age, to a current level of about 310 ppb. Global concentrations of chlorofluorocarbons (CFC's) may have leveled out or started to decline since 1995 in response to the regulations of the Montreal Protocol. However, their substitutes, which include hydrochlorofluorocarbons and perfluorocarbons, which are also greenhouse gases, are currently increasing.

The effectiveness of a greenhouse gas in warming the earth can be measured in terms of its radiative forcing. If one considers changes in greenhouse gases since 1750, CO_2 has the largest effect in terms of radiative forcing. The others, ranked in order of importance, are CH_4, ozone, halocarbons, and N_2O. Anthropogenic aerosols in the atmosphere, which are generated by industrial pollution and biomass burning, have a net cooling effect that is difficult to quantify. In addition, aerosols may affect cloud properties and cloud cover, which could result in surface cooling. However, these effects are very difficult to quantify. Changes in solar radiation may also have contributed to global temperature increases in the early part of the twentieth century, but the importance has been difficult to evaluate.

Elevated concentrations of greenhouse gases are predicted to persist in the atmosphere for varying lengths of time based on mathematical models that simulate future additions and removals. The persistence of greenhouse gas concentrations that are predicted by these models is subject to large uncertainties in the effects of both natural processes and human activities (Ledley et al., 1999). Prather (1996, 1998) estimated a "mean residence time" of 10 years for CH_4, 100 years for N_2O, and 50-100 years for CFC's. However, the complex behavior of CO_2 exchange with the ocean and sediments precludes the use of simple models for determining the persistence of anthropogenic CO_2 in the atmosphere (Ledley et al., 1999). Various analyses of the different CO_2 exchange processes suggest that much of the excess CO_2 in the atmosphere will remain there for decades to centuries, and 15-30 percent will remain for thousands of years (Schlesinger, 1990; Sarmiento et al., 1992; Archer et al., 1998; Stallard, 1998).

An IPCC workgroup (IPCC, 2001a) has concluded that the global average surface temperature has increased throughout the 20^{th} century by about 0.6 degrees Celsius (°C). This temperature increase was only interrupted by a cooling trend between 1945 and 1976. Daily minimum temperatures over land have been increasing by about 0.2 °C per decade, while daily maximum temperatures have increased by about 0.1 °C per decade. The group also determined that there is a high likelihood that snow cover and ice extent have decreased in the 20^{th} century and that precipitation has increased, especially in mid- and high latitudes of the Northern Hemisphere. They also judged that it is likely that there has been an increase in the frequency of heavy precipitation events in the mid- and high latitudes of the Northern Hemisphere. The workgroup concluded that there is strong evidence that most of the warming observed over the last 50 years is attributed to human activities.

Future projections of greenhouse gas emissions over the 21^{st} century have been made using a range of assumptions about economic growth, population, and types of technologies (IPCC, 2001a). The various projections provide a large range in possible results. The year 2100 CO_2 concentrations could range from 540 to 970 ppm. The minimum projected value is almost double that of the year 1750 figure. The climate system response to increases in greenhouse gases is investigated by the use of computer models of the earth's climate system, known as global climate models (GCM's). Most model simulations of the earth's climate suggest that an increase in the atmospheric concentration of greenhouse gases will lead to an increase in the average surface air temperature of the earth (Kattenberg et al., 1996). However, substantial uncertainties remain in the magnitude and geographical distribution of these changes and in the rates at which changes may occur (Ledley et al., 1999). A number of features of the climate system are still crudely represented in climate models. The coarse resolution of models restricts their ability to represent terrain effects or to simulate processes that occur on smaller scales. Substantial uncertainties in the predictions of GCM's include the prediction of local effects of climate change, occurrence of extreme weather events, effects of aerosols, changes in clouds, shifts in the intensity and distribution of precipitation, and changes in ocean circulation (Houghton et al., 1996; Mahlman, 1997; Hansen et al., 1998).

The IPCC workgroup (IPCC, 2001a) concluded that the globally averaged surface temperature is projected to increase by 1.4-5.8° C between the present and the year 2100. The models showed that land areas will warm more rapidly than the global average, especially in the northern high latitudes. They also predict that precipitation will increase over the northern mid- and high latitudes. However, precipitation variability in these areas is projected to increase as well. It also appears likely that the continental interiors would experience more frequent and intense summer droughts. The global mean sea level is projected to rise by 0.09 to 0.88 meters (m) due to thermal expansion and melting from glaciers and ice caps.

4.1.2.2. Potential Consequences of Global Climate Change

The IPCC (2001b) has assessed the potential consequences of global climate change. The report includes discussions on the sensitivity, adaptive capacity, and vulnerability of natural and human systems to climate change. According to the IPCC projections, crop yields in most tropical and subtropical regions would decrease, and water availability for populations in water scarce regions would decrease, particularly in the subtropics. The exposure to vector-borne and water-borne diseases would increase, and the risk of flooding due to higher incidences of heavy precipitation and sea-level rise would increase. If the global temperature increase were to rise by more than a few degrees Celsius, reduced crop yields would be likely in the mid-latitudes as well. There would also be some beneficial aspects to climate change. The increase in CO_2 levels may increase crop yields in the mid-latitudes if the increase in temperature stays relatively small. The global timber supply may increase from appropriately managed forests. There would be a reduction in winter mortality from cold weather stress in the mid and high latitudes.

The developing countries would be more vulnerable to climate change because more of the economy is sensitive to climatic variations. Many areas are prone to destructive droughts and floods. Population and agricultural centers in the tropics are often located in low-lying coastal areas, which are vulnerable to sea-level rise. Nutrition is deficient and the health infrastructure is relatively poor. There is less capacity to adapt because of limited technological, financial, and institutional resources.

The IPCC (2000c) investigated various strategies for reducing greenhouse gas emissions. Costs depend strongly on technological development and the timing and level of greenhouse gas stabilization. Lower emissions will require switching to lower-carbon fuels and increasing the efficiencies in buildings, transportation, energy production, and manufacturing. Appropriate management of forests, agricultural lands, and ecosystems could be used to sequester carbon. Progress is being made in the technological development of wind turbines, hybrid vehicles, and fuel cell vehicles. Some emission reductions, such as those resulting from increased efficiencies, could result in net cost savings. Other measures would have varying degrees of cost. The reduction in greenhouse gas emissions would have some other direct benefits, such as improved air quality. The use of emissions trading will likely reduce the cost of reaching emission reduction goals.

The National Assessment Synthesis Team (2000) has summarized the consequences of climate change for the United States. The report presents impacts by geographical regions as well as by resource (i.e., water resources, agriculture, ecosystems, coastal resources, human health). A discussion of potential climate change effects on the OCS areas considered in the proposed 5-year program is given below.

4.1.2.2.1 Gulf of Mexico Region

Changes in climate have the potential to affect a number of resources in the Gulf of Mexico by directly affecting the resources or by causing additional environmental changes (e.g., changes in stream hydrology, redistribution of sediments, and sea-level rise). Depending on the species and the area, temperature and precipitation changes can affect the distribution and abundance of resources, such as plant and animal species, through various mechanisms. In coastal areas, the rise in sea level caused by climate change may pose a larger stress on plants, animals, ecosystems, and human communities. Though these impacts may not directly affect offshore oil and gas leasing and operations, they may have indirect effects on the downstream (onshore) support operations and infrastructure necessary to exploration, development, and production operations. On the other hand, increased oil and gas leasing and operations could possibly further add to the stress induced by global climate change already experienced by these resources.

Increased occurrence of extreme weather events due to climate change may have direct impacts on oil and gas leasing and operations by precluding or delaying exploration and development activities and possibly damaging oil- and gas-related infrastructure that are not adequately designed, constructed, and maintained to withstand extreme weather events. An increase in the frequency or severity of hurricanes induced by climate change could have adverse impacts on oil and gas operations by interfering with exploration and production activities or even damaging and destroying facilities.

The resources that may be subject to stress due to climate change include wetlands, barrier islands, beaches, and other coastal ecosystems; fisheries and ocean resources, including marine mammals and sea turtles; and coastal communities. Built-up areas along the coast, including some low-lying cities such as New Orleans, will be subject to erosion, inundation, and river and storm surge flooding, and elevated salinities in coastal aquifers. Coastal farmland may also be lost due to increased soil salinity (Watson et al., 1998).

Rising sea level is gradually inundating wetlands and lowlands, eroding beaches, exacerbating coastal flooding, threatening coastal structures, raising water tables, and increasing salinity of rivers, bays, and aquifers (Barth and Titus, 1984; Titus and Narayanan, 1995). The areas most vulnerable to rising seas in North America are found along the Gulf of Mexico and Atlantic Ocean south of Cape Cod. Rising sea level can also affect oil and gas production, processing, and distribution facilities by inundating low-lying areas where facilities are located.

A 50-centimeter (cm) rise in sea level would inundate approximately 50 percent of North American coastal wetlands in the next century; many beaches would be squeezed between advancing seas and engineering structures, particularly along estuarine shores. Coastal wetlands provide important habitat and nourishment for a large number of birds and fishes (Titus and Narayanan, 1995). Many islands will be at risk. The low bay sides of developed barrier islands could be inundated while their relatively high ocean sides erode. Undeveloped barrier islands will tend to migrate landward through the overwash process. Although the barrier islands themselves are undeveloped, there are important recreational areas along the mainland coast behind the barriers as well as environmentally sensitive freshwater bogs and woodlands. Rising sea level would increase flooding and storm damage. Regional climate change could offset or amplify these effects, depending on whether river flows and storm severity increase or decrease. Rising sea level would increase the salinity of estuaries and aquifers, which would impair water supplies, ecosystems, and coastal farmland. As with coastal flooding, regional climate change could offset or amplify these effects, depending on whether river flows increase or decrease (Watson et al., 1998).

Many Gulf of Mexico commercial fish populations are already under pressure, and global climate change may be of minor concern compared with the impacts of ongoing and future commercial fishing and human use or impacts of the coastal zone. Fishes, including shellfishes, respond directly to climate fluctuations, as well as to changes in their biological environment including predators, prey, species interactions, disease, and fishing pressure. Fishes are not only influenced by temperature and salinity conditions but also by mixing and transport processes. Climate would only be one of several factors that regulate fish abundance and distribution. Projected changes in water temperatures, salinity, and currents can affect the growth, survival, reproduction, and spatial distribution of marine fish species and of the prey, competitors, and predators that influence the dynamics of these species (Watson et al., 1998).

Changes in primary production levels in the ocean because of climate change may affect fish stock productivity. However, it is still unclear how climate-induced changes in primary productivity would affect the next trophic link, zooplankton. Changes in zooplankton biomass are known to affect fish productivity.

The effects of climate change will be most pronounced for resources that are already over-utilized and where there are sharp conflicts among users. Climate change impacts, including changes in natural climate variability on seasonal to interannual time scales, are likely to exacerbate existing stresses on fish stocks. Although the effects of environmental variability on fisheries are increasingly recognized, the contribution of climate change to such environmental variability is not yet clear (Watson et al., 1998.)

Recreational fishing is a highly valued activity that could have losses in some regions because of climate-induced changes in fisheries. The net economic effect of changes in recreational fishing opportunities because of climate-induced changes in fisheries is dependent on whether projected gains in cool- and warm-water fisheries offset losses in cold-water fisheries. Annual losses of $85 million to $320 million to benefits of about $80 million are predicted under a number of future climate projections (Stephan et al., 1993). Anadromous species, such as striped bass, rely on marine and freshwater aquatic systems at different points in their life cycles. Projected changes in marine and freshwater temperatures, ocean currents, and freshwater flows are more likely to impact growth, survival, reproduction, and spatial distribution of these species than of other species.

Aquaculture potential will be affected by projected changes in climate and climate variability and could take advantage of extended favorable conditions in current marginal areas. Long-term temperature trends will affect which species of fish or shellfish are suitable for aquaculture, as well as the expansion or contraction of aquaculture sites (Watson et al., 1998).

The survival, health, migration, and distribution of marine mammals and sea turtles may be impacted by projected changes in climate through impacts on their food supply and breeding habitats. The availability of necessary habitats and prey species that results from climate change will have the greatest impact on marine mammal and sea turtle populations that are already under endangered species status. Marine mammal calving and pupping grounds and nesting beaches of sea turtles would be threatened by rising sea level (Watson et al., 1998).

4.1.2.2.2. Alaska Region

Temperatures in Alaska and throughout the arctic are thought to have fluctuated considerably over the last few centuries (Mann et al., 1999). Despite this fluctuation, the last 100 years appear to have been the warmest in the last 400 years, but may not have been the warmest of the last millennium (Overpeck et al., 1997). As predicted by global climate models, Alaska's surface air temperature has warmed throughout much of the State since at least the mid-1970's (Juday, 1987). Additionally, temperatures measured in boreholes from oil and gas exploration wells indicate that permafrost temperatures today are 2-4 °C warmer than they were 50 to 100 years ago (Lachenbruch and Marshall, 1986). In interior Alaska, discontinuous permafrost has warmed considerably (Weller et al., 1995), and in the Arctic Ocean sea ice thickness has decreased substantially (Johannessen et al., 1995). There has also been a widespread retreat of glaciers throughout the arctic over the last century

(Dowdswell, 1997). Chapin et al. (1995) suggests that climate change may already be altering the species composition of the Alaskan arctic tundra.

Continued warming of the climate could have major effects on the ecosystems of Alaska, particularly the North Slope. However, the large amount of natural variation inherent in the system limits our current understanding of the consequences of climate change. As mentioned above, permafrost temperatures have already warmed substantially. Continued change in frozen ground will likely affect construction, transportation, hydrology, ecology, and trace-gas fluxes in the arctic and subarctic regions of Alaska (Weller et al., 1995). A warmer, wetter environment with a longer growing season could greatly affect the productivity and growth form composition of tundra by the more rapid release of nutrients from decomposing soil organic matter (Nadelhoffer et al., 1991). Similarly, changes in the water table, which alter decomposition and nutrient availability, substantially alter the carbon balance of tundra and taiga microcosms (Billings et al., 1983; Funk et al., 1994). The impact of climate warming on the large amounts of soil carbon currently held in peat soils of the arctic and subarctic regions is unclear. Release of the carbon into the atmosphere by increased oxidation could exacerbate climate warming (Billings et al., 1983). However, increased temperature and precipitation may also increase primary productivity, stimulating carbon storage (Gorham, 1991).

A warmer, wetter environment with a longer growing season will have varied effects on birds and mammals. A strong positive effect on migratory birds is likely by increasing the length of time they can remain in their summer range while brood rearing, and by increasing the productivity of aquatic and terrestrial invertebrate prey species. However, shifts in vegetation toward more shrubs at the expense of grass and sedge species may negatively impact birds that feed on vegetation. Similarly, caribou and muskoxen would be negatively affected by shifts toward greater shrub domination. Milder conditions may change competitive interactions among birds and mammals by allowing species that were previously restricted by climate conditions to compete for space and food.

Warming of ocean waters may already have diminished the temporal and spatial extent of sea ice (Johannessen et al., 1995), with some models predicting an ice-free arctic (Melillo et al., 1990). A major reduction in the extent and persistence of sea ice may have large impacts on marine ecosystems. Sea ice itself is a critical habitat for arctic marine plankton (Clarke, 1988). The lower surface of the ice and interstices in the ice are highly productive habitats for plankton, which provide an important food source for herbivores both while the sea ice is in place and when it breaks up in the spring (Melillo et al., 1990). The quantitative importance of sea ice in high latitude marine ecosystems is well established, with important food web implications for fishes, seabirds, and marine mammals (Gulliksen and Lonne, 1989). Additionally, some marine mammals and birds have life history strategies adapted to sea ice. In particular, polar bears are dependent on sea-ice habitat for hunting its primary prey, seals. Impacts to marine mammal, fish, and bird populations may adversely impact Native subsistence harvests.

In subarctic waters, the effect of global warming on the plankton in near-surface waters is less well understood. Diatoms are the preferred food for many organisms in the marine food web, and when other types of phytoplankton replace them, fish productivity can be dramatically reduced (Barber and Chavez, 1983). Because they have high sinking rates, diatoms require a turbulent mixed layer. In at least some regions of the North Pacific, data imply a shift toward a thinner surface mixed layer (Freeland et al., 1997; Whitney and Freeland, 1999). The eastern north Pacific has also warmed and become less saline over the past few decades. Both warming and freshening of the surface layer stabilizes the mixed layer and reduces the amount of nutrients brought up from below the pycnocline (Welch and Batten, 1999). A warmer and wetter climate would likely make the mixed layer even more stable. Hsieh and Boer (1992) also suggest that wind mixing of the surface layer may be reduced as climate changes.

Changes at the base of the marine food chain may impact higher trophic organisms, changing the distributions and population numbers of marine fish, bird, and mammal species. Changes in the ocean-atmosphere system affecting fish populations appear to be as large as the direct effects of the major commercial fisheries (Welch and Batten, 1999). Changes in the prey base of Steller sea lions is thought to be the primary factor influencing their decline in the Aleutian Islands and the Gulf of Alaska (U.S. Department of Commerce [USDOC], National Marine Fisheries Service [NMFS], 1995). While this decline in prey species may be more related to commercial fishing, climate change might magnify the impact.

A warmer climate would have some positive effects on oil and gas development in the Arctic Ocean. With a longer ice-free season, exploratory drilling and construction activities would be less restricted by ice. Vessels would be able to reach facilities for a longer time. Structures would not be subjected as frequently to severe stresses induced by sea ice. On the other hand, any gravel islands used for the placement of an oil production facility, could be subject to greater erosion through an increase in wave action.

4.1.2.3. Contribution of OCS Activities to Greenhouse Gas Emissions

Activities associated with exploration, development, and production of OCS oil and gas resources result in emissions of greenhouse gases. The largest amount of emissions associated with production of oil and gas is in the form of CO_2. The CO_2 is produced by the diesel engines used in drilling wells, the installation of production facilities, the support vessels, and the turbines that provide power to the platforms during production. The transportation of crude oil by tankers and barges also results in CO_2 emissions. Methane and N_2O are also produced by these activities, but in much smaller amounts. The primary source of methane consists of fugitive hydrocarbon emissions from the platforms and from losses during the transport and transfer of crude. Ozone (O_3) is not emitted directly by industrial activities, but is produced by photochemical reactions involving NO_x and VOC. The OCS activities could result in only a slight localized increase in O_3; the amount on a global scale would be insignificant. Emissions of CFC's from OCS activities are negligible.

Estimates were made of the total emissions of CO_2 and CH_4 for all activities associated with the proposed 5-year program. Emissions of N_2O were not calculated due to lack of information about emission factors. However, these emissions are expected to be much smaller than for the other greenhouse gases. Estimates were based on projected number of platforms, oil and gas production figures, and vessel traffic as presented in Section 4.3.1. The basic methods used in the emissions calculations are the same as those used in Sections 4.3.2.2 and 4.3.3.2.

In the Gulf of Mexico, it is estimated that about 75 percent of the total CO_2 emissions is from production platforms, while construction and drilling activities contribute about 15 percent of the total. The remainder is primarily from exploration and construction activities. Production platforms emit more than 95 percent of the total CH_4 emissions, with most of the remainder attributed to tanker transportation. Venting produces a large portion of the platform CH_4 emissions, with the remainder coming from fugitive emission sources. In the Alaska Region, production activities emit about 75 percent of the total CO_2 emissions, while the tankers operating between Valdez and the west coast ports contribute about 10 percent to the total. Tankers produce most of the CH_4 emissions, with the remainder coming primarily from production platforms. The large contribution by the tankers is due to the large travel distance between Alaska and the west coast.

Table 4-7a lists the total calculated CO_2 and CH_4 emissions by Region. The tables present a range of values for each planning area, corresponding to the low and high values of the resource estimates, respectively. The figures represent the annual emission rates averaged over the lifetime of the proposed 5-year program. Peak year emissions would be considerably higher. In most cases, the peak year emissions would be about twice the average emissions. The emissions are given in terms of metric tons carbon equivalent (TCE). This measure takes into account the relative global warming potential of the gas. This is determined by the radiative forcing function of the gas and the expected residence time in the atmosphere. By this measure, on a per unit mass basis, CH_4 is 21 times more effective in causing surface warming than CO_2.

The nationwide CO_2 and CH_4 emission rates for 1998 are 1,494 million and 180.9 million TCE, respectively (U.S. Environmental Protection Agency [USEPA], 2000a). The CO_2 emissions have been increasing at the rate of about 1 percent per year. The CO_2 emissions from the proposed 5-year program are about 0.04-0.07 percent of the nationwide CO_2 emissions. The combined CO_2 and CH_4 emissions from the proposed 5-year program are about 0.04-0.08 percent of the nationwide total. The estimated current global CO_2 emission rate from combustion sources is about 6.2 billion TCE. The CO_2 emissions from the proposed 5-year program would be about 0.01-0.02 percent of the global total. The global anthropogenic CH_4 emission rate is estimated to be about 2.0 billion TCE. The estimated combined CO_2 and CH_4 emissions from the proposed program would be about 0.01-0.02 percent of the global totals.

Table 4-7b presents the total estimated CO_2 and CH_4 emissions from all projected future OCS activities. The estimated CO_2 emissions from all OCS activities are about 0.15-0.22 percent of the nationwide CO_2 emissions. The combined CO_2 and CH_4 emissions are about 0.2-0.3 percent of the nationwide totals. The CO_2 emissions from the cumulative OCS program would be 0.04-0.05 percent of the global combustion emissions. The estimated combined CO_2 and CH_4 emissions from OCS program activities would be about 0.04-0.06 percent of the global emissions.

Various mitigation strategies may be pursued to reduce the greenhouse gas emissions from OCS oil and gas development activities. Use of more energy-efficient engines would reduce CO_2 emissions. The use of gas instead of diesel fuel to provide power on platforms would significantly reduce emissions. However, many operators already primarily rely on produced gas once production starts. More efficient scheduling of transport of material and personnel could lower service vessel CO_2 emissions by reducing the number of vessel and helicopter trips. Application of optimum power settings on vessels would reduce fuel use and, hence, greenhouse gas emissions.

Reducing the amount of flaring and venting would significantly reduce greenhouse gas emissions. Venting constitutes the largest source of CH_4 emissions in the Gulf of Mexico Region. More intensive programs to check for fugitive leaks on platforms would lower CH_4 emissions. The use of a lighter color of paint on storage tanks reduces vapor losses because it results in the lowering of the temperature within the storage vessel. The use of vapor balance lines by tankers during crude oil transfer would lower CH_4 emissions.

4.1.3. Invasive Species

On February 3, 1999, the President of the United States signed the Invasive Species Executive Order. This Executive Order mandated that all Federal Agencies, whose actions might affect the status of invasive species, should identify these actions and use programs and authorities to prevent the introduction of invasive species. They should also control and monitor invasive species populations, provide restoration of native species and habitat, conduct research on invasive species, and promote public education on invasive species. Invasive species has been defined as a species that is not native to the ecosystem being considered and whose introduction may cause economic or environmental harm or harm to human health.

The Executive Order also required the development of an Invasive Species Management Plan. This document was finalized on January 18, 2001, and presents nine priorities for addressing invasive species problems, and recommended actions for solving these problems. Examples of the problems to be addressed include prevention, early detection and rapid response, restoration, and research.

Nationwide, invasive species are associated with environmental damages and losses totaling over $138 billion annually (Pimentel et al., 2000). Over 50,000 invasive species have been documented to date in the United States. Roughly 42 percent of threatened and endangered species are considered at risk primarily because of invasive species.

Invasive species have become established in new environments through several routes. Some have been intentionally introduced. The striped bass (*Morone saxatilis*) is intentionally released to stock San Francisco Bay on an annual basis by the California Department of Fish and Game to increase sport fishing activity. Others are brought in through accidental releases or escapes such as the blue tilapia (*Oreochromis aureus*) species in Florida (Gulf of Mexico Fisheries Management Council, 1998), and Atlantic salmon (*Salmo* salar) now inhabiting the Pacific northwest. Still others are accidentally introduced when they somehow escape detection and are brought in and accidentally released, such as the zebra mussel transported and dumped from ship ballast.

Effects of invasive species can be devastating on both habitat and native species and may (1) include a decrease in biological diversity of native ecosystems, (2) decrease the quality of important habitats for native fish and invertebrate species, (3) reduce habitats needed by threatened and endangered species, (4) increase direct and indirect competition with aquatic plants and animals, and (5) pose human health risks.

OCS Activities and Invasive Species Interactions

Some oil and gas activities may play a part in the introduction of invasive species. Still others may provide substrate and habitat encouraging the establishment of invasive species. These organisms may also create problems through fouling of boat hulls and intakes.

Drillships and semisubmersibles are used and relocated throughout the world's oceans. Over time, fouling, encrusting, and boring organisms will attach to these devices. Unintentional introductions may occur when these drill rigs are relocated to a new region such as the Gulf of Mexico. These same drillships and semisubmersibles may transport and release ballast water containing invasive plankton and larval invertebrates, which may then become established due to the availability of acceptable habitat, plentiful food supply, and lack of predators.

Since 1998, there are at least 16 documented cases of rigs being brought into the Gulf of Mexico from other parts of the world. Some rigs operating in the Gulf of Mexico were constructed or recently modified in Singapore, Taiwan, and Scotland. Newly built rigs undergoing their last year of construction stand in waters of surrounding shipyards. A year is sufficient time for fouling and encrusting organisms to colonize rig surfaces. One large semisubmersible was kept in Mobile Bay for 1 year. Prior to Mobile Bay, it had spent 6 months drilling off the coast of Trinidad.

Oil and gas drilling rigs, platforms, and pipelines provide substrate and habitat for sessile organisms. Invasive mussels, barnacles, and corals are known to use rigs and platforms as attachment sites. Many marine organisms require hard surfaces to use as attachment sites for all or part of their natural history. Jellyfish have a polyp stage that requires hard substrate. Polyps settling on rigs in one location and then transported to another region can asexually reproduce. One polyp can produce up to 300 new jellyfish. Currently in the Gulf of Mexico, oil and gas platforms provide 12.1 square kilometers (km^2) of hard substrate (Louisiana State University, Coastal Marine Institute, ongoing). No-activity-zone natural reefs provide 104.5 km^2 of hard substrate, which could be used for settlement sites.

Above-water platform structures may also encourage the colonization of new habitat by invasive species. Many migratory bird species use the platform structures as stopover spots while crossing the Gulf of Mexico. The cattle egret colonized North America in the last half-century. This is also one of the most common species observed on platforms in the Gulf of Mexico. Use of the platforms as rest stops may have been the catalyst that allowed the cattle egret to expand its range. Ongoing research funded by MMS is studying the interactions between migrating birds and oil and gas structures off the Louisiana coast.

Invasive species may cause fouling problems on water intakes. There are several activities associated with offshore oil and gas development and production that could be negatively affected. Fire pump tests on production facilities sometimes show a reduced water intake rate due primarily to fouling by barnacles. The intakes on water makers used to take up and process seawater for showers, dishwashing, and drinking could potentially become clogged by fouling. During drilling processes, cooling water intake lines on vessels and semisubmersibles may also become clogged.

Gulf of Mexico Invasive Species

The edible brown mussel (*Perna perna*) is native to Africa and South America and is similar to the zebra mussel in its habit of fouling hard substrates, including native mollusks. Unlike the zebra mussel, however, it is a marine/estuarine organism, and may have been introduced either through the dumping of ballast water or transported attached to the hulls of ocean-going vessels. The brown mussel was discovered on the Texas coast in 1990 at Port Arkansas and, since that time, has spread southward to Veracruz, Mexico, and northeast to the Freeport, Texas, area. Range expansion southward has been more rapid and extensive than northward. This is believed to have been due to the prevailing east to west long- shore surface currents on the Texas coast, and possibly due to temperature effects during the winter seasons.

The Australian spotted jellyfish (*Phyllorhiza punctata*) and the pink jellyfish (*Drymonema dalmatina*), both from Caribbean waters, were found in tremendous concentrations in the Gulf of Mexico in the summer of 2000. They were observed concentrated in the passes between the barrier islands that separate Mississippi Sound and the Gulf of Mexico. This area was also concentrated with planktonic larvae and eggs of shrimp, crabs, and many important fish species that spawn offshore as they drifted on the currents to inshore nursery areas of the Sound. The loss of these juveniles could reduce the potential adult population of that year class. If these jellyfish persist in high concentrations in successive years, many commercially important fisheries may be affected in the long term. The USDOI MMS is funding research on the Australian spotted jellyfish. This research will study the relationship of this species to OCS platforms.

Other invertebrates not native to the area have been found in the Gulf of Mexico, including hydroids (*Cordylophora caspia* and *Garveia franciscana*), sea anemone (*Diadumene lineata*), and polychaete worms (*Hydroides elegans* and *Ficopomatus enigmaticus*). All may cause fouling problems on marine surfaces (Carlton, 1997).

The Atlantic copepod (*Centropages typicus*) was found in Texas in the 1980's and was probably introduced by ballast water. Four invasive barnacle species (*Balanus amphitrite*, *B. reticulatus*, *B. trigonus, and Tetraclita stalactifera stalactifera*) are now abundant in the Gulf of Mexico. *Sphaeroma walkeri*, *S. terebrans*, *Limnoria spp*. and *Ligia exotica* are four species of isopod, (two native to the Indian Ocean). *Sphaeroma terebrans* is having negative impacts on mangrove development areas (Carlton, 1997).

Wood-boring bivalve mollusks of the genus *Lyrodus* (shipworms) were likely introduced to the Gulf of Mexico from the Indo-Pacific region during the days of wooden-hulled ships. An eastern Atlantic limpet-like snail (*Siphonaria pectinata*) was probably introduced with ballast rocks during the 19^{th} century.

Alaska Invasive Species

Twenty four species of invasive plants and animals have been identified in Alaskan waters. Fifteen of these species were found in Prince William Sound. Four zooplankton species found are believed to have been released in the ballast water of tankers from East Asia by way of San Francisco Bay.

There are current invasive species monitoring activities in Prince William Sound, Seward, and Homer. Among other activities, these programs include surveying for the potential continued northward colonization by European green crabs (*Carcinus maenus)*. To date, no crabs have been documented as far north as Alaskan waters. Researchers are also placing biofouling plate arrays in the water during the summer to look for fouling organisms.

Pacific Invasive Species

The European green crab has been found along the Washington Coast. This European native is a small shore crab known to be an able colonizer and efficient predator. It has been blamed for the collapse of the Maine soft-shell clam industry. This crab was first found in San Francisco Bay in 1989 and is moving northward. It has also recently been found in Coos Bay, Oregon, and Willapa Bay in Washington State. The crab may have accidentally been introduced through boat ballast, seaweed used for packing bait, and as live bait themselves.

During the summer of 2000, *Caulerpa taxifolia* was discovered in two separate California coastal embayments: Agua Hedionda Lagoon and Huntington Harbor. This alga grows as a dense blanket covering and killing native marine vegetation. Eradication efforts are under way. It may have been introduced accidentally by aquarium enthusiasts.

4.1.4. Effects of the Physical Environment on Oil and Gas Operations

Exploration, development and production activities on the OCS must be conducted in accordance with an approved exploration or development and production plan. The operator must submit an analysis of seafloor and subsurface geologic and manmade hazards; historic weather patterns and other meteorological conditions; physical oceanography including currents, tides, and sea states of offshore areas; and measures to minimize or mitigate their potential effects.

These and other environmental conditions are taken into consideration during the design, fabrication, transportation, and installation of the platform. Design considerations are based on an assessment of the conditions expected to occur at the installation site over the life of the structure. The design reflects the consideration of various environmental factors that represent the most severe conditions that are anticipated. Specific consideration is given to wave conditions, wind velocities, current velocities, temperature, sea ice and snow conditions, and earthquake information.

4.1.4.1. Geological Hazards

Gulf of Mexico

Geologic hazards are any geologic features or processes that can inhibit the exploration and development of petroleum resources. The main geohazards on the shelf and slope and their principal results are as follows:

- faults—sediment tectonics, halokinesis (salt dome movement);
- slope stability—slope steepening, slumps, creep, debris flow;
- gassy sediments—strength reduction, hydrates (frozen gas and water), liquefaction;
- fluid and gas expulsion features—strength reduction, liquefaction;
- diapiric structures—salt, mud, hydrates;
- seafloor depressions—blowouts, pockmarks;
- seafloor feature—sediment waves, differential channel fill, brine-low channels, seabed furrows;
- shallow water flow—strength reduction, liquefaction; and
- deep high-velocity currents—megafurrows, seabed erosion.

Major faults on the continental slope are associated with massive accumulation of sediments and are called growth faults. These growth faults form along with and continuously with sediment deposition. The growth faults are found mostly on the upper continental slope and on the continental shelf where sediment accumulation is the thickest

Two factors control the near-surface submarine slope stability of the continental margins off Texas and Louisiana. These are (1) an interplay between episodes of rapid shelf edge progradation and contemporaneous modification of the depositional sequence by diapirism; and (2) mass movement processes. Many slope sediments have been uplifted, folded, fractured, and faulted by diapiric action. Oversteepening on the basin flanks and resulting mass movements have resulted in the appearance of highly overconsolidated sediments underlying extremely weak pelagic sediments (USDOI, MMS, 2000).

Shallow waterflow, also known as geopressured sands, is the uncontrolled flow of sand and water that can create sediment accumulation at the wellhead. It is the result of compaction, disequilibrium, or differential compaction and usually occurs at 360-530 m below the seafloor. It is more likely to occur on the upper and middle slope and less likely to occur above the salt nappe, the tabular salt blocking the escape of overpressures from below (USDOI, MMS, 2000).

Water currents can be a problem to structures on the continental shelf and upper slope. Deepwater high-velocity currents may be a major problem to structures such as platforms, bottom assemblies, and pipelines at the base of the Sigsbee Escarpment (1,200-3,300 m) in the Central Gulf of Mexico Planning Area. Recent studies have revealed the presence of large megafurrows at the base of the Sigsbee Escarpment. These large bedforms, 20-30 m wide and as deep as 10 m, occur along the base of the Sigsbee Escarpment and extend to a distance of 20 km south of the escarpment. They are the result of high-velocity bottom currents occurring along the base of the escarpment (Bryant and Liu, 2000).

Alaska

Various geologic hazards may inhibit petroleum exploration and development in the Alaskan OCS planning areas. These hazards can be generally categorized into subsurface hazards, active processes, or tectonic processes.

Subsurface hazards include shallow gas accumulations, abnormal formation pressure, subsea permafrost, and active faults. Shallow gas accumulations may result in unstable bottom conditions that affect structures by inhibiting the normal consolidation of sediments, or they may cause gas blowouts during drilling. Excessive formation pressures are also a potential hazard to drilling operations, but can be managed by safe drilling practices. Subsea permafrost on the Beaufort Sea continental shelf may contain trapped gas and may melt during the drilling of wells or the subsequent production activities in areas surrounding the borehole. This could cause subsidence and rupture of the well casings, leading to loss of well control. Active faults could disrupt buried pipelines and damage drilling structures.

Active processes that present hazards to oil and gas operations include bottom scour, ice gouging, slumping, subsidence, and sea ice. Current induced sedimentation and erosion may modify seafloor topography, causing burial and undermining of structural supports. Deep draft keels of free-floating icebergs and ice islands produce deep gouges in the seafloor that can disrupt buried pipelines and bottom founded structures. Slumping and subsidence may also disrupt buried pipelines and damage drilling structures. Moving masses of sea ice present a major engineering constraint and potential hazard, and are discussed in more detail in a separate section below.

Tectonic processes that pose hazards to development include earthquakes, tsunami, fault movement, and ground tilting. Ground shaking during a major earthquake can seriously affect bottom founded structures and might cause consolidation problems in artificial gravel islands used as drilling platforms. In addition to ground shaking, earthquakes may cause uplift or subsidence, fault displacement, surface tilt, ground failure, and tsunami inundation, all of which may impact the integrity of development infrastructure. Volcanic eruptions, primarily along the Alaska Peninsula and Cook Inlet, may cause lava flows, mud slides, ash and rock deposits, earthquake swarms, and radio interference.

These hazards generally pose only engineering constraints to oil and gas development. Information on recurrence intervals for earthquake and volcanic events, proximity to active fault lines and the type of faulting, and subsurface soil conditions are used to determine the site-specific engineering requirements. Structural designs are then established to withstand greater impacts than would be predicted by the acquired information.

4.1.4.2. Sea Ice

Sea ice is a primary factor affecting offshore development of OCS reserves in the arctic region of Alaska. Moving ice floes, sheets, pressure ridges, and ice ride-up can exert strong lateral pressure on development structures. The force that ice exerts on structures depends on the strength, size, and shape of the ice and the magnitude of the force moving the ice. Sea-ice events such as ice gouging, strudel scour, and ice ride-up can cause hazardous conditions and damage to structures within a project area. Permanent drilling structures in the shear, floe, and pack ice zones have to resist the forces generated by first-year and multi-year ice. Artificial gravel islands constructed with protective concrete matting and a berm to break up ice before it contacts the island are currently being built in the nearshore Beaufort Sea for the Northstar project. Drilling units constructed of heavy steel or concrete that rest on the bottom and floating vessels strengthened to withstand ice could also be used in some situations. Platform designs developed for arctic production must resist seawater, ice, and freeze-thaw cycles.

Pipeline placement in arctic waters requires special consideration be given to strudel scour and ice gouging, which can disturb the seafloor. Ice gouging is the most severe environmental hazard for underwater structures on the arctic Alaska OCS (U.S. Army Engineer District [USAEDA], 1999). Ice gouging is caused by grounded ice keels within pressure ridges and icebergs moving in response to wind and currents (Walker, 1985). Weeks et al. (1983) observed gouges as deep as 2.6 m below the seafloor in 38-m water depths. Strudel scour occurs when water flowing through holes or cracks in the ice erodes the seafloor. Strudel scour can create deeper depressions in the seafloor than ice gouging (Vaudrey, 1985). Subsea pipelines in areas with these ice events must be buried to sufficient depths to prevent exposure of the pipeline to an ice event, and require routing of the pipeline to create minimal exposure to ice events.

Sea-ice forecasting and ice observations are used to produce maps showing the various ice types, ages, concentrations, and directions of movement. These forecasts may allow time for the well to be shut in safely if weather and ice conditions threaten operations. Ice breakers and icebreaking supply boats can, in some circumstances, perform ice management tasks to minimize hazards from sea ice during routine operations.

4.1.4.3. Permafrost

Thaw subsidence and frost heave associated with permafrost in the arctic can create potential hazards to oil and gas operations. Permafrost is present both onshore and offshore in the Beaufort Sea Planning Area, though it is primarily an onshore and nearshore constraint to oil and gas developments in the Beaufort Sea. The presence of subsea permafrost depends on seawater temperature and salinity, lithology, and the extent of shorefast ice in winter (USAEDA, 1999). There is a transition from bonded permafrost, that is unstable when thawed, on land to generally thaw-stable materials offshore. Thaw bulbs are permanently unfrozen soils found in permafrost beneath lakes and river channels, and in areas disturbed by human activities (Rawlinson, 1983). Engineered facilities within thaw bulb areas are susceptible to frost heave and frost jacking.

Activities that disrupt the thermal balance of permafrost may result in thaw subsidence. These activities include drilling through permafrost layers; building and maintaining crude oil pipelines; placement and operation of bottom-founded structures; and construction of artificial islands, causeways, and berms.

Drilling may cause permafrost to melt in the vicinity of the well. Refreezing may put pressure on the well casing and could cause structural failure of the casing. Mitigation of these hazards includes the use of drilling muds, drilling rates, cementing techniques, and casings designed for permafrost conditions. Pipeline movement caused by thaw subsidence may cause fracture or complete separation of the pipe. Insulation and refrigeration of the pipeline, and variations in pipeline diameter and depth of cover can reduce thaw subsidence associated with pipelines (USAEDA, 1999). Pipeline routes that avoid thaw areas or unstable permafrost, particularly at transitions from subsea buried pipe to onshore aboveground pipe, can also lessen the potential hazards of operation in permafrost dominated regions.

Artificial islands and causeways are also designed with seasonal freeze-thaw cycles and permafrost conditions taken into account. Structures are generally elevated and positioned on gravel thick enough to provide insulation to underlying permafrost.

4.1.4.4. Physical Oceanography

Gulf of Mexico

As noted previously in the discussion of geohazards, water currents can be a problem to structures on the continental shelf and upper slope. Deepwater high-velocity currents may be a major problem to structures such as platforms, bottom assemblies, and pipelines in certain portions of the Gulf of Mexico. Bryant and Liu (2000) have identified large megafurrows in the Central Gulf of Mexico Planning Area at the base of the Sigsbee Escarpment and Bryant Fan (i.e., in 1,200-3,300 m of water; measuring tens of meters wide and up to 10 m deep; extending tens of kilometers), which have resulted from high-velocity bottom currents occurring along the base of the escarpment.

Oceanographic currents of greatest concern are those resulting from strong, episodic wind events such as tropical cyclones (especially hurricanes), extratropical cyclones, and cold-air outbreaks. Such wind events can result in extreme waves and cause currents with speeds of 100-150 centimeters per second (cm/s) over the continental shelf. Recent examples for the Texas-Louisiana shelf and upper slope are given in Nowlin et al. (1998). Other researchers (e.g., Molinari and Mayer, 1982; Brooks, 1983, 1984) have measured the effects of such phenomena down to depths of 700 and 980 m, respectively, over the continental slopes in the northwestern and northeastern Gulf. Additional information on wind-generated waves is discussed in the following section dealing with meteorology. Episodic wind events can also cause major currents in the deep waters of the Gulf.

The phenomena of most concern to deepwater operations in the Gulf of Mexico are surface-intensified currents associated with the Loop Current, Loop Current eddies detached from the Loop Current, and other eddies (both anticyclonic and cyclonic). Currents associated with the Loop Current and Loop Current eddies extend into the water column to as deep as 1,000 m, and, in the case of the Loop Current itself, perhaps to depths approaching the sill depth of the Yucatan Channel (2,000 m). These currents can have surface speeds of 150-200 cm/s or more; speeds of 10 cm/s are not uncommon at 500 m (Cooper et al., 1990).

During the mid-1980's, deep currents were observed to exist in the Gulf from depths near 1,000 m to the bottom. Hamilton (1990) described such currents at three locations (i.e., in deepwater portions of the eastern, central, and western Gulf). These deep currents were seen to be essentially depth-independent, though some energy intensification was noted with increasing depth near the seafloor. Deep circulation patterns distinct from those associated with the surface-intensified eddies have also been seen in numerical model studies by Hurlbert and Thompson (1982) and Inoue and Welsh (1997). Public and proprietary measurements have indicated such barotropic currents have maximum speeds from near 40 to 100 cm/s. This class of barotropic currents, with possible bottom intensification, is of high interest to offshore operators attempting oil production in water depths of 1,000 m and greater; measurements of these oceanographic features are ongoing in the Western and Central Gulf of Mexico Planning Areas by MMS and offshore operators.

Several deepwater oil and gas operators have observed very high-speed, subsurface-intensified currents lasting as long as a day at locations over the upper continental slopes (i.e., water depths of 700 m or less). Such currents may have vertical extents of less than 100 m, and they generally occur within the depth range of 100 to 300 m. Maximum speeds exceeding 150 cm/s have been reported.

Meteorological data from the NOAA National Data Buoy Center (NDBC) have been used to compute significant wave height and wave period in the Gulf of Mexico. Maximum monthly significant wave heights in deep water range from 2.9 to 10.7 m. Maxima are associated with the energetic, episodic wind events such as hurricanes, which occur between June and November, or cyclogenesis events, which occur mainly between November and May (Nowlin et al., 1998).

Engineering concerns are integrated into facility design to address the potential problems associated with the unique physical oceanographic conditions of the Gulf of Mexico. For example, as development activity moves into deeper water and alternate production systems are considered, anchoring and seafloor production components for floating systems must be designed to withstand the effects of high-velocity bottom currents in those areas of the Gulf where they may occur. For conventional and alternate production systems alike, episodic wind and surface events must be considered in the design of various components for platforms and deepwater development systems.

Alaska

Ocean currents, tides, waves, and storm surges can affect offshore operations on the Alaska OCS. Ocean currents produce a steady force against vessels and structures. Currents generally do not threaten the physical integrity of production equipment or structures unless the currents push large quantities of sea ice. All offshore structures are designed to withstand forces greater than the maximum measured currents, as well as sea ice. Tides with high range, like those in Cook Inlet, may disrupt support vessel traffic during periods of low water. Waves and storm surges may also disrupt vessel traffic associated with offshore activities. Storms may require various activities to be halted, including personnel transfer and offloading of oil from platforms to tankers. Extreme weather and ocean conditions may occur off Alaska, particularly in the Pacific Margin. Winter storms frequently have sea waves greater than 16 m. Freezing spray on vessels can affect their buoyancy and stability, resulting in ship sinkage.

4.1.4.5. Meteorology

Gulf of Mexico

Storms and associated high winds and waves are the primary meteorological conditions that affect offshore operations in the Gulf of Mexico. In addition to the concerns noted over currents, storms (e.g., hurricanes, cyclones, etc.) also produce surface waves that contain considerable energy. Significant wave height represents one measure of this energy potential. For example, Tracy and Cialone (1996), presenting meteorological data from Hurricane Opal (an intense category 4 hurricane in October 1995), cited maximum significant wave heights of 10 and 8 m in deep and shallow water sites, respectively, in the Gulf. Hurricane Andrew generated significant surface waves of 4 to greater than 6 m over both the deep water and the Texas-Louisiana shelf (Stone et al., 1993; Breaker et al., 1994).

Hurricanes, however, are not the only intense storms that can generate significant waves. Approximately 10 times each year, winter cyclones develop over the Gulf of Mexico in a process called cyclogenesis (Johnson et al., 1984; Hsu, 1988). Significant wave heights associated with these cyclones have been measured at greater than 9 m, comparable to a category 1 hurricane (Shumann et al., 1995).

Tropical conditions normally prevail over the Gulf from May or June until October or November. The nominal hurricane season is June 1 through November 30. From October or November until March or April, the Gulf experiences intrusions of cold, dry continental air masses. These result in the formation of extratropical cyclones and cold-air outbreaks, both of which can cause highly energetic surface currents. On average, about 10 to 12 extratropical cyclones are formed over the northern Gulf per year; the number of frontal passages varies from 1 to 2 per month in summer to over 10 per month in winter.

Energetic events, which produce the larger waves, are of great concern in the design of offshore structures. Using the Cardone et al. (1976) wave hindcast model validated by Ward et al. (1978), Haring and Heideman (1978) estimated rare wave heights associated with 22 severe hurricanes occurring in the Gulf of Mexico between 1900 and 1977. They found the model results varied little between the three sectors studied off the coasts of south Texas, east Texas-west Louisiana, and east Louisiana-Mississippi-Alabama. They found 100-year significant wave heights of 12-13 m in water depths of 70-700 m, with wave heights of 11-12 m in shallower water. Maximum 100-year wave heights were estimated to be 20-22 m.

Alaska

Storms and associated high winds, ice, snow, fog, and extreme cold are the primary meteorological conditions that affect offshore operations in the Alaska planning areas. Extreme weather and ocean conditions may occur off Alaska, particularly across the Pacific Margin. In the Gulf of Alaska, a deep low-pressure system can bring winds of devastating magnitude (> 25 m/s), although average wind speed is 8-11 m/s from October through February (Wilson and Overland, 1986). Winter storms frequently have sea waves greater than 16 m. Freezing spray on vessels can affect their buoyancy and stability, causing ships to sink. Storms, particularly those with high winds, interfere with the movement and installation of drilling rigs and can disrupt communication, surface and air support vessels, and evacuation traffic. Rough seas may directly damage equipment and disrupt boat traffic.

Fog, rain or snow often restricts visibility in the coastal regions of Alaska. Lowered visibility increases the danger of collisions with both offshore and onshore structures and may curtail support vessel traffic. The Cook Inlet and Gulf of Alaska Planning Areas have high precipitation rates along the coast, with the maximum mean monthly precipitation (8 to 10 cm/mo) during December, January, and February (Wilson and Overland, 1986). Fog occurs over the area in every month of the year, but is most prevalent in the summer and early winter months (Grubbs and McCollum, 1968; Guttman, 1975).

Extreme cold (-51^{o}C) in arctic locations with additional cold from wind-chill (equivalent of -73^{o}C) may affect equipment and personnel performance. Below freezing temperatures are experienced during more than 80 percent of the year and have been recorded during every calendar month (USAEDA, 1999). The lack of natural wind barriers in the Alaskan arctic results in unrestricted winds, at an annual average of 21.3 km per hour near the Northstar development (USAEDA, 1999). Gusting winds are highest and most frequent between September and November (USAEDA, 1999). Inupiat residents have relayed many accounts of their experiences with extreme storms. Weather is described as unpredictable and constantly changing. With little warning, sudden and extreme storms can occur in the Alaskan Beaufort Sea (J. Ningeak in USDOI, MMS, 1990b).

Analysis of historical weather patterns and meteorological conditions are important in the design of platforms and equipment used in the Alaskan OCS region. Project specifications assume an expected life of 25 years in the Beaufort Sea, 35 years in the Chukchi Sea, 25 years in the Hope Basin, 35 years in Cook Inlet, and 25 years in Norton Basin. Design is set to withstand events expected to occur within a 100-year timeframe. Monitoring of weather conditions usually provides ample warning to offshore operators and service vessel operators of approaching dangerous conditions.

4.1.4.6. Ordnance Hazards

Gulf of Mexico

Obsolete munitions as well as toxic waste and possibly radioactive materials have been dumped into several sites in the Gulf of Mexico. This type of dumping was prohibited after 1970, but these materials may remain active for many years, and they still pose a definite hazard to oil and gas exploration and development in those areas. Live munitions are still dropped in specific areas of the Gulf during military live-fire exercises, and occasionally when emergencies force aircraft in trouble to jettison their load of live munitions. Shallow geohazard surveys are required in areas where these types of materials may be present. If such materials are discovered, special precautions must be taken.

Alaska

There are no known obsolete munitions located in offshore waters of Alaska.

4.2. Definitions of Impact Levels

The conclusions for most analyses in this environmental impact statement (EIS) use a four-level classification scheme to characterize the impacts predicted if the proposal or an alternative is implemented and activities occur as assumed.

4.2.1. Impact Levels for Biological and Physical Resources

These impact levels are used for the analysis of water quality, air quality, marine and terrestrial mammals, marine and coastal birds, fish resources, sea turtles, coastal and seafloor habitats, and areas of special concern (such as essential fish habitats, marine sanctuaries, parks, refuges, and reserves).

Negligible

- No measurable impacts.

Minor

- Most impacts to the affected resource could be avoided with proper mitigation.
- If impacts occur, the affected resource will recover completely without any mitigation once the impacting agent is eliminated.

Moderate

- Impacts to the affected resource are unavoidable.
- The viability of the affected resource is not threatened although some impacts may be irreversible, OR

- The affected resource would recover completely if proper mitigation is applied during the life of the project or proper remedial action is taken once the impacting agent is eliminated.

Major

- Impacts to the affected resource are unavoidable.
- The viability of the affected resource may be threatened, AND
- The affected resource would not fully recover even if proper mitigation is applied during the life of the project or remedial action is taken once the impacting agent is eliminated.

4.2.2. Impact Levels for Societal Issues

These impact levels are used for the analysis of demography, employment, and regional income; land use and infrastructure; fisheries; tourism and recreation; sociocultural systems; environmental justice; and archaeological resources.

Negligible

- No measurable impacts.

Minor

- Adverse impacts to the affected activity or community could be avoided with proper mitigation.
- Impacts would not disrupt the normal or routine functions of the affected activity or community.
- Once the impacting agent is eliminated, the affected activity or community will return to a condition with no measurable effects from the proposed action without any mitigation.

Moderate

- Impacts to the affected activity or community are unavoidable.
- Proper mitigation would reduce impacts substantially during the life of the project.
- The affected activity or community would have to adjust somewhat to account for disruptions due to impacts of the project.
- Once the impacting agent is eliminated, the affected activity or community will return to a condition with no measurable effects from the proposed action if proper remedial action is taken.

Major

- Impacts to the affected activity or community are unavoidable.
- Proper mitigation would reduce impacts somewhat during the life of the project.
- The affected activity or community would experience unavoidable disruptions to a degree beyond what is normally acceptable.
- Once the impacting agent is eliminated, the affected activity or community may retain measurable effects of the proposed action indefinitely, even if remedial action is taken.

4.3. Environmental Impacts of Alternative 1—Proposed Action

4.3.1. Scenario

The analyses in this document consider the adoption of a schedule of sales indicating, as precisely as possible, the size, timing, and location of leasing activities associated with the proposed action and four alternatives to the proposed action. Hypothetical scenarios were developed to provide a framework for the impact analyses.

4.3.1.1. Basic Assumptions

These scenarios are based on the assumption that the areas under consideration for lease are actually leased and then developed. Estimates of the amount of hydrocarbons which might be discovered and produced were made to form the basis for the level of exploration, development, and production activity. These anticipated production values were also used to make assumptions concerning oil spills.

The analyses in the environmental impact statement (EIS) assume the implementation of all mitigation measures required by statute or regulation. In addition, the impact analysis assumes that sale-specific lease stipulations which were commonly adopted in past lease sales are in effect (Appendix D). The protection afforded by the provisions of these stipulations is present in the analysis of the resources being mitigated. A particular analysis may not contain a reference to lease stipulations because no stipulation applies to that environmental resource. The analysis presents the environmental consequences of the alternatives with the applicable stipulation. However, some stipulations were found not to afford any significant mitigation to the resources. For those resources, no significant difference was found between the analysis with or without the stipulation. An EIS will be prepared for each lease sale, or group of sales, scheduled in the program that will include an analysis of the potential impacts with and without the commonly-adopted stipulations in effect. Therefore, an analysis will be available of the effects of not adopting particular stipulations.

4.3.1.2. Resource Estimates and Anticipated Production

Estimating the undiscovered resource base and economically recoverable hydrocarbons expected to be leased, developed, and produced is a difficult task because of the various uncertainties associated with the process. The existence and amount of hydrocarbon accumulations are not known until actual exploratory drilling has taken place. The only information regarding the possible existence of hydrocarbons is derived from analogs, extrapolations, and geologic and geophysical interpretations.

Seismic data, especially 3-D seismic, provide clues to the existence, locations, and areal extent of possible hydrocarbon bearing structures. However, without geologic information from drilling, no real data will be available regarding types of reservoir rocks, source rocks, geopressure, and geochemistry of potential prospects. Therefore, exact predictions of the amounts and areal extent of any hydrocarbon resources are virtually impossible to make.

For this EIS, we used resource estimates from the 2000 National Assessment which estimates the undiscovered, conventionally and economically recoverable oil and natural gas resources located outside of known oil and gas fields on the U.S. Outer Continental Shelf (OCS). The assessment considers recent geophysical, geological, technological, and economic information and uses a play analysis approach of resource appraisal called the Geologic Resource Assessment Program (GRASP).

This assessment began with the geologic analyses of the OCS areas using the extensive library of public and proprietary data available to U.S. Department of the Interior (USDOI) Minerals Mangement Service (MMS) assessors. These include seismic data and interpretations, well log data and interpretations, petrophysical and geochemical data, geologic maps and cross sections, and a vast array of additional data and information available to MMS through its Federal regulatory responsibilities for OCS resource management.

For the purpose of the current assessment, the geologic plays are classified into three groups based on the level of exploration and discovery history: (1) established plays, (2) frontier plays, and (3) conceptual plays.

In recognition of the differences in the extent of data and information available among the OCS areas, (attributable mostly to the degree of past exploration and development activities), some variances in the use of GRASP modules and procedures were incorporated. Where available data are sparse and good analogs not identified, the frontier and conceptual plays are analyzed through the subjective probability method utilized by GRASP. In this method, individual distributions of input variables are subjectively prepared, and through GRASP, ranked (prospect) pool-size distributions are generated. Most plays in the Alaska OCS and some in the Pacific OCS were analyzed this way. In the case of frontier plays, where the assessors feel confident that an analog exists, such as in the Atlantic OCS, the analysts can generate a pool-size distribution from the statistical parameters of the appropriately scaled, ranked pool-size distribution of the analog plays and can estimate the play resources using GRASP.

For established plays, such as in the Gulf of Mexico and Southern California where significant amounts of pool data are available from discovered fields, a pool-size distribution curve for a play can be generated from the distribution of discovered pools.

The estimates of undiscovered oil and natural gas resources attributed to basins, provinces, regions, or other areas are derived through statistically aggregating the play-level potential resource distributions of the plays comprising that area.

The ranked pool-size distributions, generated by GRASP, are the basic geologic inputs into a second model—the Probabilistic Resource Estimates Offshore (PRESTO) model. The costs of exploration, development, and transportation, as well as tariffs based upon logical scenarios are estimated for each area where activities, costs, or other circumstances warrant. Estimates for economically recoverable resources are then derived for a specific price. The resources that would exceed the economic hurdles are then totaled. The process is repeated many times for numerous prices, and a continuous distribution curve is generated.

The current estimates of undiscovered economically recoverable OCS oil and natural gas resources were developed using the following criteria:

- flat prices (no real price changes);
- 12-percent discount rate (after tax rate-of-return);
- 12.5-percent or 16.7-percent royalty rate;
- 35-percent tax rate;
- 3-percent inflation rate;

- cost of exploration, development, transportation, and tariffs with their associated development scheduling scenarios for each OCS Region and portions of Regions when conditions warrant; and
- natural gas prices related to oil prices at 66 percent of the oil-energy equivalent.

All of the information derived from the National Assessment can be used by the decisionmaker along with the following:

- models which estimate the number of blocks expected to be leased;
- past statistics/analytical reasoning regarding the number of leased blocks which will be drilled;
- analyses regarding the number of blocks expected to be drilled which will yield discoveries; and
- analyses regarding the number of expected discoveries, which will be large enough to be commercial.

All of these factors are reflected in subjective estimates for anticipated production (Tables 4.1a and b).

4.3.1.3. Exploration and Development Assumptions

Hypothetical scenarios concerning exploration and development activities were developed to provide a framework for the impact analysis. The estimates of offshore infrastructure required to support exploration and development of the hydrocarbon resources are based on existing conditions for each region. Tables 4.1a and b provide estimates of infrastructure assumed to be required to discover and produce the oil and gas in each planning area. Various factors are considered when developing the exploration and development infrastructure: geology of the area, costs associated with exploration and development, presence of existing infrastructure to transport oil or gas to market, and environmental conditions in the area. Because these factors vary from region to region, the infrastructure required to find and develop similar volumes of hydrocarbons differs among the regions. For example, the number of wells assumed for the scenarios in the Western and Central Gulf of Mexico Planning Areas is greater than in other regions. The western and central Gulf are mature areas with proven prospects and multiple traps for hydrocarbons. Numerous wells would be needed to explore, delineate, and develop these prospects. On the other hand, in frontier areas such as the Alaska Region, only the largest prospects can be explored because of the high costs involved and the unproven geologic potential of the area. Therefore, significantly fewer exploration wells would be drilled.

These same conditions also influence the number of development wells required. Because of several factors in the Gulf of Mexico, especially the existing infrastructure, many relatively small prospects can be developed in the region. Similar size prospects in the Alaska Region could not be developed at this time because of higher costs and the lack of existing infrastructure. Therefore, more development wells are assumed for the scenarios in the western and central Gulf of Mexico than in Alaska.

Estimates of the level of offshore and onshore activities which may result from the exploration, the delineation of possible hydrocarbon bearing formations, and the establishment of production platforms are also based on the following assumptions:

- The areas under consideration for lease are assumed to be leased and developed.
- The amounts of oil and natural gas assumed to be discovered, developed, and produced is based on the condition that economically recoverable amount of hydrocarbons are present in the planning areas.

- The level of infrastructure for each area under consideration for lease is based on the assumption that all of the conditional resources allocated to each sale will be produced independent of the likelihood of finding hydrocarbons.

4.3.1.4. Transportation and Market Assumptions

The exact mode of transport of oil and gas cannot be determined until the amount of recoverable reserves is known and judgments are made as to what is environmentally preferable and technically and economically feasible. Therefore, the assumptions listed below were made concerning how oil and gas production could be transported to shore and whether production would be transported by tanker or pipeline to markets inside or outside of the areas being considered for lease. Assumptions are provided for the eight planning areas being considered for lease sales in the proposed program. In developing these assumptions, the current and proposed transportation networks to demand areas were reviewed.

Assumptions whether to use pipelines, barges, or tankers to transport OCS oil and gas to shore take into consideration technological and environmental constraints and economic considerations. Although pipelines are generally preferred, in some instances where economics and other considerations do not justify their construction, tankers or barges are assumed.

Gulf of Mexico Region:

- Approximately 90 percent of the oil from the Western and Central Gulf of Mexico Planning Areas would be transported to shore by the extension and expansion of the existing offshore pipeline system.
- Less than 1 percent of the oil from the Western and Central Gulf of Mexico Planning Areas in nearshore areas would be transported by barge; approximately 10 percent of the oil produced in deepwater would be transported to shore by shuttle tanker.
- Gas from the Western and Central Gulf of Mexico Planning Areas would be transported to shore by pipeline through the extension and expansion of the existing pipeline system. Gas pipelines from deep waters of the Eastern Gulf of Mexico would connect to existing pipelines in the Central Gulf of Mexico which come ashore in the delta area of Louisiana.
- One hundred percent of the oil from the Eastern Gulf of Mexico Planning Area would be transported by pipeline to existing facilities in the Central Gulf of Mexico Planning Area.
- New onshore facilities would include marine terminals and pipeline yards.

Alaska Region:

- The lifting of the export ban on Alaskan crude oil has led to some shipments to East Asia. These shipments are infrequent and generally of limited quantities responding to transitory spot market opportunities. The vast majority of oil transported via the Trans-Alaska Pipeline System (TAPS) is still being sent to the U.S. West Coast.
- Oil from the Beaufort Sea and Chukchi Sea Planning Areas would be transported by new subsea and overland pipelines to the TAPS. The TAPS would carry the oil south to the marine terminal facilities in Valdez where it would be loaded on tankers and shipped primarily to West Coast ports. Natural gas will be reinjected to maximize oil recovery.
- Natural gas from the Hope Basin Planning Area would be produced from offshore production facilities and transported to shore by subsea pipeline to meet a growing local market for natural gas. Condensate separated from the wet gas would be stored in a tank farm and transported seasonally by tankers to processing facilities in Cook Inlet.

- Oil from the Cook Inlet Planning Area would be transported from production platforms to shore using new subsea pipelines. New onshore common-carrier pipeline systems would deliver oil to existing refineries in Nikiski and gas to transmission facilities in the Kenai area. Oil would be refined and marketed locally. Gas would be used locally as fuel for commercial and residential utilities.
- Natural gas from the Norton Basin Planning Area would be transported from production platforms to shore by subsea pipelines. The gas would be used by communities and industries centered in Nome, Alaska. No oil would be produced from Norton Basin. Condensate separated from the wet gas would be stored in a tank farm and transported by tanker in the summer open water season to processing facilities in Cook Inlet.

Pacific Region:

- Alaska OCS oil transported by tanker to West Coast ports would be handled by existing onshore facilities. Some of the oil spills assumed to occur from Alaska OCS tankers could occur along the U.S. west coast.

4.3.1.5. Oil-Spill Assumptions

4.3.1.5.1. Large Oil Spills

To provide a framework for the impact analysis of oil spills, assumptions are made concerning the likelihood of oil spills of 1,000 bbl (bbl) or greater occurring. Since the accidental discharge of oil can occur during almost any stage of exploration, development, or production, we use spill rates based on historical accidents to estimate the mean number of spills assumed to occur.

Several revisions of the spill rates have been made (Lanfear and Amstutz, 1983; Anderson and LaBelle, 1990; and Anderson and LaBelle, 1994; Anderson and LaBelle, 2001). In the most recent revisions, "Update of Comparative Occurrence Rates for Offshore Oil Spills" (Anderson & LaBelle, 2001), oil-spill occurrence rates were calculated for the entire data record (Table 4.1c). The length of the record varied by spill source:

- OCS platform and pipeline spills, 1964-1999
- tanker spills worldwide, 1974-1999
- barge spills in U.S. waters, 1974-1999
- Alaska North Slope crude oil tanker spills, 1977-1999

In addition, the rates were calculated for the last 15 years of data available (1985-1999). The 15-year period was selected in order to provide a time period over which all the spill sources could be compared. An advantage of the 15-year record is that it may be more representative of current technology and regulations. The advantage of using the entire record is that it may include larger size spills that may not have occurred within the 15-year period. (In all oil-spill distributions, the larger the spill size, the less frequent the occurrence.) In general, the difference in the 15-year spill rates and those for the entire record are too small to affect the oil-spill assumptions used for the analysis (Table 4.1d).

Table 4.1e (Oil-Spill Assumptions) presents the number of large oil spills assumed to occur as a result of the production and transportation of oil from the planning area. The source and number of assumed spills were based on the volume of anticipated oil production, the assumed mode of transportation (pipeline and/or tanker), and the spill rates for large spills. It is also assumed that these spills would occur with uniform frequency over the life of the proposed action.

The probability of one or more spills occurring in a given production period was estimated using the mean number of spills in a Poisson distribution. Table 4.1e presents the probabilities of one or more spills of 1,000 bbl or greater. These probabilities are based on the total mean number of spills estimated to occur as a result of oil production from the planning areas.

Assumptions regarding the location of spills are based on the source of the spill, the transportation and market assumptions, location of existing infrastructure, and the location of the resources being analyzed. Platform spills were assumed to occur in the area proposed for consideration for lease. Pipeline spills were assumed to occur between the proposed area for consideration for lease and the existing infrastructure. Tanker and barge spills were assumed to occur along the tanker and barge routes. Additional assumptions concerning oil spills may be stated by the analyst within the impact analysis of their resource.

Spills from tankers carrying oil produced in the Beaufort and Chukchi Sea Planning Areas are assumed to occur outside of those planning areas. Oil produced in the Beaufort and Chukchi Sea Planning Areas would be transported by the TAPS to the Valdez terminal facilities and then transported by tanker to west coast ports. Based on the destination and amount of the TAPS oil shipped from Valdez to west coast ports (Puget Sound, Washington, San Francisco, and Los Angeles, California), it is reasonable to assume that tanker spills could occur along the tanker routes to these ports.

The size of an oil spill can vary greatly depending on the amount of oil released over a period of time as a result of a single accidental event. For purposes of analysis, hypothetical spill sizes were developed from the OCS and U.S. tanker spill databases and estimates from actual development plans. The sizes of the assumed spills are approximately equal to the mean of the historical spills for each spill type (platform, pipeline, tanker, or barge). The assumed spills are: platforms—1,500 bbl; pipeline—4,600 bbl; tankers—5,300 bbl for the Gulf of Mexico and 7,800 bbl for tankers carrying Alaska OCS oil.

4.3.1.5.2. Small Oil Spills

For purposes of analysis, small spills are defined as spills greater than 1 bbl and less than 1,000 bbl and are usually the result of transferring or lightering operations, pipeline leaks or breaks, and platform mishaps. The number of small spills that could occur as a result of the proposed action in all the planning areas was estimated using data on historical spills associated with oil production in the Pacific and Gulf of Mexico Regions (Table 4.1e). Similar estimates are not available for the Alaska Region because there has been no oil production on the Alaska OCS to use as a basis to calculate small spill rates. The factors that influence small spills, such as operating procedures and environmental conditions, differ considerably in the Gulf of Mexico and Alaska Regions. However, small spill estimates were generated for Alaska waters using historic OCS spill rates as a proxy for otherwise unidentified rates. Small spills are further subdivided into two categories: spills greater than 1 bbl and less than 50 bbl, and spills greater than or equal to 50 bbl and less than 1,000 bbl. Smaller spills usually occur near ports, and often the spill as well as any effects are only short-term. Seventy-six percent of these smaller spills are less than 10 bbl. These spills, while more numerous, are more easily contained or cleaned up and usually are of limited damage potential.

Requirements for reporting spills to MMS have varied through time as to size classes reported and protocols for reporting. At present, 30 CFR 254.46 requires that industry immediately notify the

National Response Center (1-800-424-8802) if they observe: (1) an oil spill from their facility; (2) an oil spill from another offshore facility; or (3) an offshore spill of unknown origin. In the event of a spill of 1 bbl or more from their facility, the operator must orally notify the MMS District Supervisor without delay, and follow up with a report in writing within 15 days after the spillage has been stopped. Reports on spills of more than 50 bbl must include information on the sea state, meteorological conditions, and the size and appearance of the slick. The Regional Supervisor may require additional information if it is determined that an analysis of the spill response is necessary. Because of the historical variations on reporting requirements for spills of less than 1,000 bbl, the statistics should not be viewed as an accurate record of all possible spills. However, they can be helpful in establishing limits on spill occurrence.

The spill-rate calculations employed information on the number of spills less than 1,000 bbl and the annual OCS production from 1985 to 1999. These spill rates differ from rates calculated for spills of 1,000 bbl or greater because they are arithmetic averages rather than rates estimated using statistical and trend analysis techniques. The assumed number of small spills presented in table 4.xd are based on calculations of the estimated mean number of small spills using the anticipated production for each program area and the historic OCS small spill record. It is also assumed that the small spills would occur with uniform frequency over the life of the proposed action.

4.3.2. Gulf of Mexico Region

4.3.2.1. Water Quality

4.3.2.1.1. Marine Waters

Routine Operations

Routine activities potentially affecting marine water quality include placement and removal of structures and operational discharges and wastes.

Placement of drilling units and platforms produces turbidity due to disturbance of bottom sediments. Pipeline trenching, required in water depths less than 61 meters (m), also produces turbidity along pipeline corridors. This impact is not avoidable. However, water quality would return to normal (e.g., background concentrations of suspended solids) within minutes to hours, without mitigation.

Important routine discharges during oil and gas operations include drilling muds and cuttings and produced water. Operational discharges are regulated by the final National Pollutant Discharge Elimination System (NPDES) permit issued by the U.S. Environmental Protection Agency (USEPA) regions in either Dallas or Atlanta.

The environmental effects of drilling muds and cuttings, including synthetic-based fluids (SBF's), (in areas where they are permitted under the NPDES general permit and MMS regulations) are localized and reversible (Neff, 1987; Candler et al., 1993; Montagna and Harper, 1996). Drilling fluids also known as drilling muds, are a suspension of various solids and additives in a base fluid. They are used to remove drill cuttings from the hole, control well pressure, and lubricate the drill string. Cuttings are the fragments of rock that are generated as the drilling bit grinds and crushes the formation being drilled. The two basic categories of drilling fluids are water-based fluids (WBF's) and nonaqueous based fluids.

At present, there are two studies of the effects of SBF cuttings discharges in progress. These studies should provide additional information concerning environmental effects of such discharges in deep water. Compliance with NPDES permits will minimize impacts on receiving waters (e.g., by limiting contaminant concentrations).

Produced water is formation water that is brought to the surface during gas and oil production. For routine oil and gas production operations in the Gulf of Mexico, produced water is the largest individual discharge. Generally, the amount of produced water is low when production begins but increases over time near the end of the field life. In a nearly depleted field, production may be as high as 95 percent water and 5 percent fossil fuels (Read, 1978; Stephenson, 1991). Produced water may have specialty chemicals added during the treatment process. Produced water can have elevated concentrations of several constituents, including inorganic salts, petroleum hydrocarbons, some metals and naturally occurring radioactive material (NORM).

Petroleum hydrocarbons in produced water discharges are a major environmental concern. The most abundant hydrocarbons in produced water are the one-ring aromatic hydrocarbons, benzene, toluene, ethylbenzene, and xylene (BTEX) compounds and low molecular weight saturated hydrocarbons. Produced waters from wells in the northwestern Gulf of Mexico contain 68 to 38,000 micrograms per liter (μg/L) total BTEX. Toluene is often the most abundant BTEX compound in Gulf Coast produced water, followed by benzene.

Polycyclic aromatic hydrocarbons (PAH's) are hydrocarbons that contain two or more fused aromatic rings and are the petroleum hydrocarbons of greatest environmental concern in produced water due to the toxicity of some PAH's and their persistence in the marine environment (Neff, 1987). Naphthalene, phenanthrene, and their alkyl homologues are the only PAH's occasionally present at higher than trace concentrations.

The NORM include the radium isotopes ^{226}RA plus ^{228}Ra, and may occur at trace concentrations in produced water. Levels of radium isotopes (^{226}RA plus ^{228}Ra) in produced water range from 0.2 picocuries/liter (pCi/L) to 2802 pCi/L (Neff, 1997). Modeling by the USEPA, in conjunction with laboratory tests, indicates that produced water discharges reach nontoxic levels within 100 m of the discharge point, assuming discharge rate up to 25,000 bbl per day (USDOI, MMS, 1998a).

Impacts on water quality are low due to rapid dilution and dispersion, which limits effects to within meters of the discharge source (USEPA, 1993a). Compliance with NPDES permits is assumed to minimize impacts on receiving waters (e.g., through limitations on concentrations of toxic constituents). Water quality would recover without mitigation when discharges ceased.

Other waste discharges, including sanitary and domestic waste and deck drainage, occur from manned platforms, drilling vessels, and service vessels, and are potential contributors to degradation of offshore water quality. Discharges include sanitary wastes, domestic wastes, bilge water, and deck drainage. Sanitary and domestic wastes are routinely processed through onsite waste treatment facilities before being discharged overboard. Deck drainage is processed onsite to remove oil and is then discharged. Sand and sludge are containerized and shipped to shore for disposal.

Bilge water discharges can contain petroleum and metallic compounds leaked from machinery. Assumed discharges of waste and bilge water from support vessels are presented in Table 4-1a. The scenario (Table 4-1a) indicates the number of vessel trips expected in the Gulf of Mexico. Compliance with NPDES permits and U.S. Coast Guard regulations would avoid most impacts, and water quality would quickly recover without mitigation.

Accidents

Marine water quality would be affected by any of the oil spills that could occur under the proposed action. These include a pipeline spill (4,600 bbl) in each of the three Gulf of Mexico Planning Areas. In the Central Gulf of Mexico Planning Area, the scenario also includes a platform spill (1,500 bbl) in shallow water and a tanker spill (5,300 bbl) in deep water. The Western Gulf of Mexico Planning Area also includes one shallow platform spill. A number of small spills are also assumed in each of the three planning areas (Table 4-1a).

Oil spills would not persistently degrade water quality for several reasons. First, oil spills of the assumed sizes would not last long and would, therefore, not be a continuing source of potential contaminants. Second, most of the components of oil are not soluble in water, and the spilled oils generally have densities less than seawater. Therefore, the spilled oil tends to float and undergo weathering at the sea surface (National Research Council [NRC], 1985). A subsurface spill could introduce minor concentrations of oil into the water column, but this would not measurably degrade water quality except perhaps in the immediate vicinity of the rising oil plume. This localized degradation would cease after the release of oil had stopped.

Conclusion: Overall marine water quality impacts in the Gulf of Mexico due to routine operations, such as structure placement and operational discharges, under the proposed action would be **minor**. Compliance with NPDES permit requirements would minimize or avoid most impacts to receiving waters, and water quality would recover when discharges ceased.

4.3.2.1.2. Coastal Waters

Routine Operations

Routine activities potentially affecting coastal water quality include structure placement (pipeline landfalls) and operational discharges. The proposed action scenario assumes a maximum of five pipeline landfalls each in the Central and Western Gulf of Mexico Planning Areas. Pipelines passing through coastal waters would be buried, with the trenching operations producing turbidity along pipeline corridors. This impact is not avoidable. However, water quality would return to normal (e.g., background concentrations of suspended solids), without mitigation.

Assumed levels of vessel-associated discharges have been discussed previously under marine water quality. Bilge water inputs in the larger channels should assimilate the daily inputs, and no changes in water quality would be detected over time. However, in confined portions of some channels there may be insufficient capacity of the water to assimilate the bilge water and sanitary wastes. This may result in some regional degradation of water quality. Compliance with NPDES permits and U.S. Coast Guard regulations would avoid most impacts on receiving waters, and water quality would quickly recover. The impacts of vessel-associated discharges would therefore be minor.

Accidents

Two shallow water spills in the Central Gulf of Mexico Planning Area could affect coastal water quality, a pipeline spill (4,600 bbl) and a platform spill (1,500 bbl) (Table 4-1e). For this analysis, it is also assumed that a platform spill in the western Gulf of Mexico and a pipeline spill (4,600 bbl) in the Eastern Gulf of Mexico Planning Area would occur in shallow water. It is assumed that neither the tanker spill (5,300 bbl) in the Central Planning Area nor the pipeline spill (4,600 bbl) in the Western Planning Area are likely to affect coastal water quality because these would occur in deep water.

If a spill were to occurs in enclosed coastal waters or is driven by winds, tides, and currents into an enclosed coastal area, water quality would be adversely affected. In such a low-energy environment, the oil would not be easily dispersed, and weathering could be much slower. Effects on water quality could be persistent oil were to reach coastal wetlands and were deposited in fine sediments, becoming a chronic pollution source. Proper cleanup of spills could be necessary for recovery of the affected area. Shoreline cleanup operations may involve crews working with sorbents, hand tools, and heavy equipment. Oiled shorelines may also be washed with warm or cold water, depending on beach type.

Small oil spills (Table 4-1e) would produce measurable impacts on water quality, but would rapidly recover without mitigation due to evaporation and weathering.

Conclusion: Overall coastal water quality impacts due to routine operations such as structure placement and operational discharges under the proposed action would be **minor**. Compliance with NPDES permit requirements would minimize or avoid most impacts to receiving waters, and water quality would recover when discharges ceased. Oil spills in shallow water in the Gulf of Mexico could affect water quality in any of the three Gulf of Mexico Planning Areas, and the impact would be unavoidable. Impacts of small spills would be **minor** because the resource would recover without mitigation. Impacts of large spills in the Central and Eastern Planning Areas could be **minor** to **moderate** because effects could persist without cleanup of affected coastal areas.

4.3.2.2. Air Quality

4.3.2.2.1. Routine Operations

The most commonly emitted air pollutants associated with Gulf of Mexico OCS oil and gas activities include nitrogen oxide (NO_x), sulfur dioxide (SO_2), 10-micron particulate matter (PM_{10}), carbon monoxide (CO), and volatile organic compounds (VOC). Nitrogen oxides consist of nitric oxide and nitrogen dioxide (NO_2) and are formed through the chemical combination of oxygen in nitrogen during combustion. The most common NO_x sources associated with OCS activities are diesel engines used in construction, drilling and support activities, gas reciprocating engines, turbines, and support vessels. Also generated in the combustion of fuels, though in much smaller quantities, are SO_2, PM_{10}, and CO. The main sources on the OCS are marine vessels and platform diesel engines. Sulfur dioxide is also generated during flaring and gas processing, especially on platforms where sour gas is produced. Emissions of VOC result primarily from fugitive emission sources, venting, crude oil storage, and crude oil transport activities.

The USEPA has established national ambient air quality standards (NAAQS) for NO_2, SO_2, PM_{10}, CO, lead (Pb), and ozone because of their potential adverse effects on human health and welfare. There are no significant emissions of Pb from OCS activities, so this pollutant is not discussed here further. Ambient levels of NO_2, SO_2, PM_{10}, and ozone all can contribute to respiratory illnesses, especially in persons with asthma and the elderly, and can also aggravate heart disease. Ozone in the lower atmosphere, as opposed to ozone in the stratosphere (which is beneficial to life because it screens out harmful ultraviolet radiation) is a major health hazard. Ozone has a particularly adverse effect on respiratory function as it causes irritation and inflammation of the lung airways. People with respiratory problems are the most vulnerable, but even healthy people that are active outdoors can be affected when ozone levels are high. Repeated exposure to ozone pollution for several months may cause permanent lung damage. In addition to the direct health effects, there are numerous interactive secondary effects. The NO_x combines with VOC under the influence of sunlight and high temperatures to form ozone as well as various organic radicals that have adverse health effects.

Furthermore, NO_x compounds react with ammonia and moisture in the atmosphere to form ammonium nitrate particles, which contribute to the PM_{10} concentrations. The SO_2 in the air can combine with moisture to form tiny sulfate particles, which also causes health problems. Carbon monoxide is a health hazard mainly in urban areas where there is a high concentration of vehicular traffic. Persons exposed to elevated levels of CO suffer from oxygen deprivation which can cause nausea and impairment of brain function.

These pollutants also are linked to various adverse environmental effects. Emissions of NO_x and SO_2 combine with moisture in the atmosphere to form acidic aerosols, which eventually return to the ground in the form of acid precipitation. In many cases, the deposition takes place hundreds of miles from the source. Acid rain can damage forests and crops, change the makeup of soil, and in some cases, may make lakes and streams acidic and unsuitable for fish. Deposition of nitrogen from NO_x emissions also contributes to nitrogen load in water bodies, especially estuaries. Acid rain as well as ambient SO_2 accelerates the decay of building materials and paints, including irreplaceable monuments, statues, sculptures, and other cultural resources. Particulate matter, including sulfate and nitrate particles and aerosols that form part of photochemical smog, significantly reduce atmospheric visibility. Long-range transport of these particles affect visibility in many of the nation's national parks and monuments. Ozone interferes with the ability of plants to produce and store food, which makes them more susceptible to disease, insects, other pollutants, and harsh weather. It may cause damage to the leaves of trees and other plants, thereby affecting the health and appearance of vegetation in cities, national parks, and recreation areas. Ozone may reduce crop and forest yields and may make plants more vulnerable to disease, pests, and harsh weather.

In the Gulf of Mexico west of 87.5° W. longitude, OCS air emissions are regulated by the USDOI, MMS, under the Code of Federal Regulations, Title 30, Part 250, Sections 302-304 (30 CFR 250.302-304). An operator submitting a plan for exploration or development activities provides emissions information for MMS review. If the emissions exceed a certain threshold, which is determined by distance from shore, a modeling analysis is required to assess air quality impacts to onshore areas. If the modeled concentrations exceed certain significance levels in an attainment area (the area meets the NAAQS), best available control technology would be required on the facility. If the affected area is classified nonattainment, emission offsets would be required. Onshore concentrations are also subject to the USDOI maximum allowable increases above a baseline level. These limits are the same as those that USEPA applies to the onshore areas under their Prevention of Significant Deterioration (PSD) program. All of the Western and Central Gulf of Mexico Planning Areas fall under the USDOI MMS jurisdiction.

Facilities located east of 87.5° W. longitude would be under the USEPA jurisdiction, which regulates air emissions under 40 CFR Part 55. For facilities located within 25 miles of a State's seaward boundary, the regulations are the same as would be applicable if the emission source were located in the corresponding onshore area and would include State and local requirements for emission controls, emission limitations, offsets, permitting, monitoring, testing, and monitoring. For facilities located beyond 25 miles of a State's seaward boundary, the basic Federal air quality regulations apply, which include the USEPA emission standards for new sources and the PSD regulations.

The type and relative amounts of air pollutants generated by offshore operations vary according to phase of activity. The three phases are exploration, development, and production. A more detailed discussion of emission sources with each phase is presented in Jacobs Engineering Group (1989). During the drilling of exploratory wells, the main sources of air emissions are from diesel engines that power the drilling units. There are also emissions from flaring during well testing. The primary emissions are in the form of NO_x. In the development phase, platforms and pipelines are installed, and production wells are drilled. Emissions are associated with derrick barges, tugboats, cranes, and crew and supply vessels. Diesel engines are the main source of power in these operations, and NO_x emissions predominate.

In the production phase, the primary emission sources are natural gas turbines and gas reciprocating engines that provide power for oil pumping, gas reinjection, and gas compression. Other pollutant sources include fugitive VOC emissions from oil/gas processing, pump and compressor seals, valves, connectors, storage tanks, and glycol dehydrator units. Flaring may take place during upset conditions, resulting in emissions of NO_x, SO_2, and VOC. If the produced gas is high in hydrogen sulfide, a desulfurization unit is used to remove sulfur. If the unit malfunctions, flaring of sour gas may be necessary for a short period.

It is estimated that about 10 percent of the crude oil produced in the Western and Central Gulf of Mexico Planning Areas by the proposed 5-year program will be transported to shore via tanker or barge. The transport of crude oil would result in VOC emissions from loading operations and breathing losses during transit. Volatile organic compound emissions would also occur during unloading and ballasting in port. There would also be emissions of NO_x, SO_2, and PM_{10} from the ship engines.

Projected 5-Year Program Air Emissions

Air emissions associated with the proposed 5-year program were estimated using emissions information collected for the Gulf of Mexico Air Quality Study [GMAQS] (USDOI, MMS, 1995a). Emission rates were set for certain general categories of OCS activity, such as exploration well drilling, platform installation, and production platforms. Annual emissions were then projected by assuming a certain development schedule over the estimated 40-year life of the activities. During the first few years, emissions are relatively low as the first few exploration wells are drilled. Emissions increase as platforms and pipelines are installed, production wells are drilled, and platforms start producing oil and gas. Emissions are projected to reach a peak around the years 2013 to 2016 when most of the platforms have been installed and are producing. After the peak emissions are reached, there is a gradual decline over the years as production rate decreases and some of the platforms are removed. There is a considerable amount of uncertainty in these emissions estimates. It is difficult to project the number of wells and platforms as well as the oil/gas production rates. Actual emissions from individual platforms vary considerably depending upon their production rates and configuration. Emissions from deepwater operations are difficult to estimate because of uncertainties in the scale of these operations in the future and the lack of data. Changes in technology also make it difficult to project emissions over a 40-year time span.

The estimated peak annual emissions for the Western, Central, and Eastern Planning Areas are shown in Tables 4-8a, 4-8b, and 4-8c, respectively. The tables show a range of emissions; the low and high emission values reflect the low and the high resource estimates, respectively. A major portion of the emissions is in the form of NO_x. About 10 percent of the total NO_x emissions over the period of projected activities are associated with exploration and production drilling activities. About 60 percent of the NO_x emissions are from production platforms. About another 15 percent of NO_x emissions are from platform and pipeline installation activities. Service vessels account for about 12 percent of total emissions. A very similar distribution is found for the year of peak emissions, except that emissions from drilling activities take up a somewhat larger portion of the total, while the percentage of emissions associated with production is a little lower. About 70 percent of the total SO_2 emissions over the period of projected activities are associated with production platforms. About 7 percent of the total SO_2 emissions are associated with exploration and production drilling activities. About another 6 percent of SO_2 emissions are from platform and pipeline installation activities. Service vessels account for about 16 percent of total emissions.

About 44 percent of the total PM_{10} emissions are associated with service vessels, while about another 37 percent of the emissions come from production platforms. The remainder comes from drilling activities, platform and pipeline installation, and tanker exhaust. About 90 percent of the VOC emissions comes from production platforms. Most of these are associated with fugitive emission sources. About another 5 percent of the VOC emissions is attributed to tanker loading and transit loss.

Impacts from NO_2, SO_2, PM_{10} , and CO

The MMS performed a cumulative air quality modeling analysis for platform sources that were operating in the Gulf of Mexico in the year 1992 (USDOI, MMS, 1997). The impact area that was modeled covered most of the coastline of Louisiana and extended eastward to include Mississippi and Alabama. Facility emissions were obtained from the emissions inventory generated in the GOMAQS. The emission values were multiplied by a factor to account for any growth that may have occurred since the data were generated. The modeled onshore annual average NO_2 concentrations were generally somewhat greater than 1 microgram per cubic meter ($\mu g/m^3$). The highest values appeared in the Mississippi River Delta region, where a maximum concentration of 6 $\mu g/m^3$ was calculated. This is 6 percent of the Federal standard for NO_2. This is attributed to the concentration of OCS development off southeastern Louisiana in the Central Planning Area. The highest predicted annual average, maximum 24-hour average, and maximum 3-hour average SO_2 concentrations were 1.1, 13, and 98 $\mu g/m^3$, respectively. These values are 1, 4, and 7 percent of the NAAQS for these respective averaging periods. Modeling was not performed for PM_{10}, but those concentrations should be considerably lower than the modeled SO_2 concentrations.

The projected emissions for the proposed 5-year program activities are only a fraction of the emissions used in the modeling. The contribution of pollutant concentrations from the proposed 5-year program would therefore be lower than the values generated in the modeling analysis discussed above. The maximum allowable increase for the annual average NO_2 concentration is 25 $\mu g/m^3$ for PSD Class II areas. A direct comparison between modeled concentrations and the maximum allowable increases is not possible because one would have to subtract emissions that existed at the time of the baseline date, which for NO_2 is 1988. In addition, onshore emission sources were not modeled. Any increases in onshore as well as offshore emissions after the baseline date would have to be included. Based on historical data on oil and gas production in the Gulf of Mexico OCS, the level of activity in 1992 is about the same as that for 1988. Therefore, the concentrations predicted by the model of the year 1992 sources are close to the baseline level. From 1992 to the present, there has been about an 8-percent growth in gas production and a 60-percent growth in oil production. As a result, current emission levels should be higher than 1992 emissions. Nevertheless, even if one were to add the projected 5-year program emissions to the current emissions, the OCS contributions would still be well within the Class II increment.

The maximum allowable concentration increases for PSD Class II areas for the three averaging periods are 20, 91, and 512 $\mu g/m^3$, respectively. The baseline year for SO_2 is 1977. From 1977 to 1992, there has been about a 20-percent increase in gas production and a 10 percent increase in oil production. Since 1992, emissions have increased by some additional amount as mentioned above. However, if one were to consider this growth along with the projected 5-year program emissions, the OCS contributions would still be well within the maximum allowable increases for Class II areas. Concentrations of PM_{10} should also remain well within the Class II maximum allowable increases.

The maximum allowable increases for the annual average NO_2 concentration in the Breton National Wilderness Area, which is a Class I area, is 2.5 μg/m^3. The highest predicted annual average NO_2 concentration in Breton from the year 1992 emission sources was 3.6 μg/m^3 (USDOI, MMS, 1997). Again, a direct comparison between the modeled concentrations and the maximum allowable increases is not possible because one would have to subtract emissions that existed at the time of the baseline date. The highest predicted SO_2 concentrations in Breton were 0.3, 4.5, and 9.7 μg/m^3 for the annual, maximum 24-hour average, and maximum 3-hour average concentrations, respectively. The maximum allowable concentration increases for PSD Class I areas are 2.0, 5.0, and 25 μg/m^3, respectively. Based on the foregoing discussions about emissions growth since the applicable baseline years, the impacts from the proposed 5-year program would be within the Class I maximum allowable increases.

Nevertheless, there has been concern about the combined impact of offshore and onshore emission sources on the Class I increments in Breton. For this reason, the MMS is gathering information for generating emission inventories for OCS facilities located within 100 kilometers (km) of the Breton Class I area. The emissions data will be used by MMS in modeling to evaluate the contribution of OCS sources to pollutant concentrations in Breton. In addition, the MMS has initiated a consultation program with USDOI, Fish and Wildlife Service (FWS). Under this program, the FWS has an opportunity to review plans for activities within 100 km of Breton that exceed a certain emission threshold. Mitigation measures, such as the use of low-sulfur fuel, are applied to the larger emissions sources.

No modeling has been performed for CO. In OCS waters, CO emission sources less than about 7,000 tons/year are exempt from air quality review under the MMS air quality regulations. This is based on air quality modeling that was performed to support the MMS air quality rules. The peak-year CO emission rate for the whole Central Gulf of Mexico Planning Area is only about 1,300 to 4,000 tons/yr. Therefore, no significant impacts from CO would be expected.

The existing concentrations of NO_2, SO_2, PM_{10}, and CO are well within the NAAQS. The emissions associated with the proposed 5-year program would result in only a very small increase in concentrations, and total levels would remain well within the NAAQS.

In summary, the concentrations of NO_2, SO_2, and PM_{10} would be within the applicable maximum allowable increases. The concentrations of NO_2, SO_2, PM_{10}, and CO would remain well within the NAAQS. The impacts from the proposed 5-year program on the pollutant levels would be minor.

Ozone

The impacts from OCS activities on ozone were evaluated in the GMAQS (USDOI, MMS, 1995). The study focused on the ozone nonattainment areas in Southeast Texas and the Baton Rouge, Louisiana, areas. It was determined through modeling that OCS sources contributed little to onshore ozone concentrations in either the Southeast Texas or the Baton Rouge areas. At locations where the model predicted ozone levels exceeded the standard of 0.12 parts per million (ppm), OCS emissions contributed less than 2 parts per billion (ppb) to the total concentrations. These contributions were realized in only a small geographic area during any particular episode. This is less than 2 percent of the ambient standard. At locations where the model predicted ozone levels were much less than 0.12 ppm, the highest OCS contributions was around 6 to 8 ppb. When the modeling was performed after doubling the OCS emissions, the highest OCS contributions at locations where the predicted ozone levels exceeded the standard was 2 to 4 ppb. The projected activities from the proposed 5-year program would cause only a slight increase in emissions above existing levels. The impacts on ozone would therefore be very small.

The implementation of the new 8-hour Federal standard for ozone may affect the relative influence of OCS emissions. The revised standard, which is 0.08 ppm for the 8-hour average ozone concentration, is more stringent than the 1-hour standard. It is likely that a number of Gulf coastal areas that presently meet the 1-hour standard will not meet the new 8-hour standard. These may include a number of counties in coastal Louisiana, Mississippi, Alabama, and Florida. An analysis conducted using modeling results from the GMAQS suggested that OCS emissions contributed a maximum of about 5 to 6 ppb to the total ozone concentrations in those areas in Southeast Texas and Louisiana where the predicted 8-hour average levels exceeded 0.08 ppm. As with the 1-hour standard, the highest contributions were realized in only a small geographic area at any particular time. The projected activities from the proposed 5-year program would cause only a slight increase in emissions above existing levels. The OCS impacts, in relation to the revised ozone standard, would therefore be small. However, the potential effects of OCS emissions on ozone will be studied in the near future. The MMS is preparing a Gulfwide emissions inventory for the year 2000. This inventory will be used for ozone modeling to evaluate OCS effects with respect to the new ozone standard.

Ambient ozone concentrations presently exceed the Federal standard in a number of Gulf coastal areas. The contribution from existing OCS emissions is small (at most about 2 percent of the total concentrations). The added contribution from the proposed 5-year program would be much smaller than this figure. The impacts on ozone would therefore be minor.

Visibility

Gaseous and fine particulate matter in the atmosphere can potentially degrade atmospheric visibility. The most important source of visibility degradation is from particulate matter in the 1- to 2-micron size range. These particles are directly emitted into the atmosphere through fuel burning. However, other sources arise through chemical transformation of NO_2, SO_2, and VOC into nitrates, sulfates, and carbonaceous particles. Existing visibility in the eastern United States, including the Gulf States, is impaired due to fine particulate matter containing primarily sulfates and carbonaceous material. High humidity is an important factor in the Gulf coastal areas in visibility impairment. The absorption of water by the particulate matter makes them grow to a size that enhances their ability to scatter light, and hence aggravates visibility reduction. The application of visibility screening models to individual OCS facilities has shown that the emissions are not large enough to significantly impair visibility. It is not known to what extent aggregate OCS sources contribute to visibility reductions. However, the individual emission sources from the proposed 5-year program are relatively small and scattered over a large area, and it is not expected that, as a whole, they would have a measurable impact on visibility. The impacts on visibility would be negligible.

4.3.2.2.2. Accidents

Small accidental oil spills would cause small, localized increases in concentrations of VOC due to evaporation of the spill. Most of the emissions would occur within a few hours of the spill and would decrease drastically after that period. Large spills would result in emissions over a large area and a longer period of time. Hanna and Drivas (1993) modeled the emissions of various hydrocarbon compounds from a large spill. A number of these compounds, including benzene, ethylbenzene, toluene, and o-xylenes, are classified by the USEPA as hazardous air pollutants. The results showed that these compounds evaporate almost completely within a few hours after the spill occurs. Ambient concentrations peak within the first several hours after the spills starts and are reduced by two orders of magnitude after about 12 hours. The heavier compounds take longer to evaporate and may not peak until about 24 hours after spill occurrence. Total ambient VOC concentrations are significant in the immediate vicinity of an oil spill, but concentrations are much reduced after the first day.

In situ burning of a spill results in emissions of NO_2, SO_2, CO, and PM_{10}, and would generate a plume of black smoke. Fingas et al. (1995) describes the results of a monitoring program of a burn experiment at sea. The program involved extensive ambient measurements during two experiments in which approximately 300 bbl of crude oil were burned. It found that during the burn, CO, SO_2, and NO_2 were measured only at background levels and were frequently below detection levels. Ambient levels of VOC were high within about 100 meters (m) of the fire, but were significantly lower than those associated with a nonburning spill. Measured concentrations of PAH were low. It appeared that a major portion of these compounds was consumed in the burn.

McGrattan et al. (1995) modeled smoke plumes associated with in situ burning. The results showed that the surface concentrations of particulate matter did not exceed the health criterion of 150 ug/m^3 beyond about 5 km downwind of an in situ burn. This is quite conservative as this health standard is based on a 24-hour average concentration rather than a 1-hour average concentration. This appears to be supported by field experiments conducted off of Newfoundland and in Alaska.

In summary, any air quality impacts from oil spills would be localized and of short duration. Emissions do not appear to be hazardous to human health. The impacts from in situ burning are also very temporary. Pollutant concentrations would not be expected to be within the NAAQS. The air quality impacts from oil spills and in situ burning would therefore be minor.

Conclusions: The impacts from routine operations associated with the proposed 5-year program on levels of NO_2, SO_2, PM_{10}, CO, and ozone would be **minor**. Air quality impacts from accidental oil spills or in situ burning would be **minor**.

4.3.2.3. Marine Mammals

Two species of particular concern for this analysis are the endangered sperm whale (*Physeter macrocephalus*) and West Indian manatee (*Trichechus manatus*). The sperm whale is the only common endangered whale in the Gulf. The West Indian manatee is a coastal species that is usually found in coastal and inshore waters of peninsular Florida, well away from most offshore OCS activities (Section 3.1.2.1). Analyses of impacts of routine operations, as discussed for sperm whales, generally apply to nonlisted (neither threatened nor endangered) marine mammals. Because drilling and production activities would occur only in OCS waters, manatees are unlikely to be affected by any routine operations. This includes noise from seismic surveys, drilling and production operations, explosive platform removals, operational discharges and wastes, and OCS vessel traffic.

Five endangered mysticete species (northern right, blue, fin, sei, and humpback whales) also may occur in the Gulf of Mexico. However, all are considered rare or extralimital in the Gulf of Mexico (see Section 3.1.2.1) and are, therefore, not likely to be affected by either routine OCS activities or accidents (negligible impact).

Two nonlisted mysticete species and 20 nonlisted species of odontocetes are found in the northern Gulf of Mexico (Section 3.1.2.1). The most commonly sighted cetaceans on the continental shelf (in terms of numbers of sightings) are bottlenose dolphins and Atlantic spotted dolphins. On the continental slope, commonly sighted cetaceans included bottlenose dolphins, pantropical spotted dolphins, Risso's dolphins, and dwarf/pygmy sperm whales.

4.3.2.3.1. Routine Operations

Impact producing factors for routine activities affecting marine mammals in the Gulf of Mexico include operational discharges and wastes, vessel and aircraft traffic, noise and structure removal. Details of routine activities assumed to occur under the proposal are provided in Table 4-1a, including the scope of exploration and development activities.

Sperm whales could be affected directly through exposure to operational discharges or ingestion of contaminated prey, or indirectly as a result of discharge impacts on prey species (NRC, 1983a; American Petroleum Institute [API], 1989; Kennicutt, 1995). However, no measurable impact is expected based on the low concentrations of discharged contaminants within an open-ocean environment, and on the short-term duration of drilling operations and installation-associated construction activities. Therefore, impacts to sperm whales and nonlisted species due to operational discharges would be negligible.

Operational discharges from OCS service and construction vessels include bilge and ballast waters, and sanitary and domestic wastes. Fluid wastes from these vessels, when permitted, would be released into the open ocean where it is expected they would be diluted and dispersed rapidly. Sanitary and domestic wastes are routinely processed through onsite waste treatment facilities before being discharged overboard. Deck drainage is processed on site to remove oil and is then discharged. Sand (from the production reservoir) and sludge (a by-product of crude oil/natural gas processing) are containerized and shipped to shore for disposal. Assuming compliance with permit requirements, waste discharges from OCS service and construction vessels would likely have no measurable impact on sperm whales, manatees, or nonlisted marine mammals (negligible impact).

Ingestion of, or entanglement with, solid debris can adversely impact marine mammals. Ingestion of plastic debris can impact the alimentary canal or remain within the stomach. Entanglement in plastic debris can result in reduced mobility, drowning, and constriction of and subsequent damage to limbs. Currently, the discharge or disposal of solid debris from both OCS structures and vessels is prohibited by the MMS (30 CFR 250.40) and the U.S. Coast Guard (International Convention for the Prevention of Pollution to Ships [MARPOL], Annex V, Public Law 100-220 [101 Statute 1458]). Assuming that these regulations are followed, most potential impacts would be avoided. Individual sperm whales may be injured, but impacts to the resource (population) from ingestion or entanglement with debris would be minor. Individual nonlisted marine mammals may be injured or killed, but impacts to the resource (population) would be minor. Due to the manatee's distribution in coastal and inland waterways, impacts resulting from solid debris discharged during OCS activities are expected to be negligible.

Estimated helicopter trips and vessel trips per week within the Gulf of Mexico Planning Areas are presented in Table 4-1a. Vessel traffic associated with routine operations may result in vessel strikes (collisions with marine mammals). Sperm whales are found within oceanic waters and are, therefore, more likely to encounter vessels travelling at high speeds, both during daylight and nighttime hours. Although sperm whales are capable of avoiding these vessels, it is possible that collisions with moving vessels may occur under certain circumstances. For example, sperm whales periodically spend extended periods of time (up to 30 minutes) restoring oxygen levels within their tissues after deep dives. Data suggest that there may be a resident population or populations of sperm whales offshore the Mississippi River Delta. Vessel operations within these areas may therefore pose a somewhat greater risk for collision. The most likely impact on sperm whales would be avoidance, rather than collision. Measurable impacts on sperm whales are possible. Although they apparently do not demonstrate strong or consistent reactions to motorized vessels, there are several reports of avoidance reactions. It is assumed that behavior would return to normal once a vessel or aircraft passed. Therefore, impacts would be minor.

Vessel strikes in inland waterways are a major cause of death in the manatee population (USDOI, FWS, 1996). However, because there are no shore bases in the Eastern Gulf of Mexico Planning Area and no new bases are assumed in the proposed action, it is highly unlikely that manatees would encounter OCS vessel traffic; therefore, impacts are expected to be negligible.

Nonlisted delphinids are agile, powerful swimmers that are capable of avoiding moving vessels, even when underway at high speed. Many delphinids are in fact attracted to moving vessels at speed, including OCS service vessels, and spend periods of time following these vessels or swimming within the bow pressure waves that are produced when traveling at speed. Impacts from moving vessels are expected to be negligible.

Sources of noise relevant to sperm whales include seismic surveys, drilling and production activities, and vessels and aircraft. Explosive structure removals are discussed as a separate impact factor. Potential impacts of seismic surveys on marine mammals have been reviewed by Richardson et al. (1995a), Davis et al. (1998), and Gordon et al. (1998). There have been no documented instances of deaths, physical injuries, or auditory effects on marine mammals from seismic surveys. However, behavioral responses have been observed in many instances, primarily in mysticetes. The biological importance of these behavioral responses (i.e., to the individual animals and populations involved) has not been determined. The sperm whale is the only listed marine mammal species that is likely to come into contact with seismic operations in the Gulf of Mexico.

Physical impacts of seismic survey noise on marine mammals may range from temporary hearing impairment to gross physical injury. Airgun sources, however, are unlikely to produce gross physical damage in marine mammals except within areas very near the airgun, a zone that would most likely be avoided by marine mammals. Animals beneath an array are exposed to the highest energy levels. Only an airgun starting up immediately next to a marine mammal would likely be injurious. Therefore, the main concern is the potential for auditory effects such as temporary or permanent hearing impairment. The auditory pathway experiences temporary and permanent impairments at lower levels of pressure or energy than other tissue (Ketten, 1995). In terrestrial mammals, including humans, exposure to strong airborne noise may cause a temporary elevation in the hearing threshold, termed temporary threshold shift, or in more extreme or prolonged cases induce permanent hearing impairment, termed permanent threshold shift (Richardson et al., 1995a). Experimental data suggest that the sperm whale may be at some risk of auditory impact from seismic survey activities. Although there are no audiograms for sperm whales, Norris et al. (2000) suggest that they have good low-frequency hearing because of their large size and use of relatively low-frequency pulsing. Sperm whales produce clicks with a frequency range from less than 100 hertz (Hz) to 30 kilohertz (kHz), with most of the energy at 2-4 kHz and 10-16 kHz (Richardson et al., 1995a). They also have distinct spectral components in their clicks at frequencies as low as 400 Hz (Goold and Jones, 1995). Although the function of these low frequency components is not clear, their presence suggests functionality and implies the ability to perceive them through the auditory system.

Seismic surveys may also result in auditory masking. Auditory masking occurs when a sound signal that is important to a marine mammal (e.g., communication calls, echolocation, environmental sound cues) is rendered undetectable due to the high noise-to-signal ratio in a relevant frequency band. In the case of seismic surveys, where potential masking noise takes a pulsed form with a low duty cycle (about 10 percent, or a 1 second disturbance in the sound field in every 10 seconds of ambient noise), the effect of masking is likely to be low relative to continuous sounds such as ship noise. Davis et al. (1998) considered masking to be of little consequence in relation to possible impacts of seismic surveys on the Scotian Shelf, largely due to the low duty cycle of seismic pulses. In contrast, Gordon et al. (1998) pointed out that signal duration increases with range from the source, and they speculated that there is some potential for masking at low frequencies, mainly of consequence to mysticetes. From either viewpoint, masking is unlikely to represent an important impact of seismic sources on listed Gulf of Mexico marine mammals.

A number of studies have documented behavioral effects in response to seismic surveys, primarily for mysticetes (Richardson et al., 1995a). However, in most cases, the biological importance of such responses (e.g., effects on energetics, survival, reproduction, population status) is unknown. Sperm whales, unlike mysticete whales, are deep diving, pelagic predators that echolocate at depth using sonar clicks, and feed on deepwater cephalopods and fishes. Auditory thresholds of adult sperm whales have not been obtained, but it is reasonable to suppose, based on their vocalizations, that they are sensitive to a wide range of frequencies. Possible sensitivity in sperm whales to low-frequency sounds has been reported (Watkins and Scheville, 1975; Bowles et al., 1994; Mate et al., 1994; Andre et al., 1997; Goold, 1999). One contradictory observation, however, reports no alteration in sperm whale vocal activity when exposed to TNT detonators (Madsen and Mohl, 2000). Sperm whales, therefore, are clearly acoustically aware of their environment and can exhibit behavioral reactions in a number of ways, including interruption of vocal activity and locomotive avoidance.

Generally, it is expected that the high motility of sperm whales would allow them to avoid or evade noises associated with ongoing seismic surveys. However, unlike mysticete whales that may remain close to the surface for long periods, sperm whales spend relatively little time at the surface during the course of feeding activity, except between periods of deep diving, where they must remain on the surface to replenish oxygen stores. During extended dives, sperm whales would be less likely to receive any surface shielding afforded by refractive effects caused by near-surface hydrographic conditions, which can occur in some instances. In addition, the sperm whale dive takes them down to a depth where they could be passed over directly by an operating seismic vessel without their being visually detected. As airgun arrays are generally configured to produce a maximum, low-frequency energy lobe directly downwards towards the seabed, sperm whales may enter a region of increased ensonification relative to more near-surface species.

There are currently no mitigation measures in place that would prevent potential impacts of seismic surveys on sperm whales in the Gulf of Mexico. If impacts were to occur, it is assumed that an animal would return to normal behavioral patterns after the survey has ceased (or the animal has left the survey area). Therefore, impacts on sperm whales due to seismic survey noise would be minor.

Generally, odontocetes demonstrate relatively poor low-frequency hearing sensitivity, and are therefore at relatively low risk from auditory impacts from seismic surveys, unless in close proximity to airgun arrays. In terms of overall risk of auditory impacts from seismic surveys, mysticetes in general are a relatively "high risk" category. Bryde's whale (*Balaenoptera edeni*) is the only mysticete occurring regularly in the Gulf of Mexico. Although there are no auditory data for the Bryde's whale, it is generally considered that the auditory abilities of all mysticete species are broadly similar, based upon vocalization frequencies and ear anatomy (Ketten, 1998). Hearing sensitivity of mysticetes at low frequencies down to approximately 10 Hz is almost certainly good. And many of the vocalizations of mysticetes occur in the low tens to a few hundred Hertz (Thompson et al., 1990; Richardson et al., 1995a; Crane and Lashkari, 1996; Rivers, 1997; Stafford et al., 1998, 1999), which implies functional hearing in this range. Seismic survey airgun arrays are configured to output maximal energy in the region of a few tens of Hertz; therefore, there is clearly a good overlap between the expected frequencies of good hearing sensitivity (low threshold) in mysticetes and maximal airgun output at source.

Behavioral responses to seismic survey noise have been observed in many instances, primarily in mysticetes. It is presumed that the Bryde's whale may respond in a similar fashion to the behavioral responses exhibited by observed species. However, the biological importance of these behavioral responses (i.e., to the individual animals and populations involved) has not been determined. Auditory masking may also be a factor for Bryde's whales due to the overlap between their presumed hearing range and the low frequency pulses generated during seismic surveys.

Other cetaceans potentially at risk for auditory effects would be beaked whales and dwarf and pygmy sperm whales. Little is known of their hearing and auditory responses. However, due to their deep diving habits, they may be at greater than average risk for auditory damage from seismic arrays passing over them.

It is presumed that the highly motile species of nonlisted cetaceans in the Gulf of Mexico may avoid or be temporarily displaced from certain areas during seismic surveys. This temporary behavioral disruption is considered a minor impact.

Noise associated with OCS drilling and production is of relatively low frequency, typically between 4.5 and 30 Hz. (Richardson et al., 1995a). The sperm whale appears to have good low-frequency hearing, but available data suggest that it may be behaviorally relatively insensitive to sounds at these frequencies. Noise associated with drilling and production is also relatively weak in intensity, and sperm whales' exposure to these sounds would be transient. Sperm whales may avoid drilling and production sites (negligible to minor impact). Nonlisted odontocetes are considered to have relatively weak low-frequency sensitivity, and impacts from OCS drilling and production noise are expected to be negligible. Mysticetes (e.g., Bryde's whale), appear to have good low-frequency sensitivity and may experience short-term behavioral disruptions (minor impact).

Although there is a certain background level of ship noise in the Gulf of Mexico, exposure of marine mammals to individual OCS support vessels and helicopters would be transient, and the noise intensity would vary depending upon the source and specific location. Observations of cetacean reactions to aircraft suggest that airborne or waterborne noise was the apparent stimulus, though vision of the passing aircraft may also be a contributing factor (Richardson et al., 1995a). Airborne sounds from OCS helicopters may be directly relevant to marine mammals while at the surface. Levels of underwater sounds from passing or hovering helicopters vary widely depending on the specific engine type and size, number of rotors, altitude and relative angle of the aircraft, depth of the receiver, and water depth. Reactions of cetaceans, including both odontocetes and mysticetes, may range from apparent indifference to evasive behavior (e.g., turns, diving, etc.). Documented observations of sperm whales to low flying helicopters showed no obvious reactions (Richardson et al., 1995a). Disturbance of marine mammals by ships and boats may be considered a more prominent source of potential impact because of the substantially greater underwater noise levels, relatively large numbers, and Gulfwide distribution of OCS service vessels as compared to aircraft. As in the case of aircraft, many of the reactions of marine mammals to vessel traffic appear to be primarily a result of noise, though there may be visual or other cues as well.

Odontocetes show considerable tolerance of vessel traffic. Many delphinid species are attracted to moving OCS service vessels, and spend periods of time following these vessels or swimming within these vessels' bow pressure waves. As mentioned above, noise related to OCS helicopter and vessel traffic in the Gulf is transient and generally not at levels that would prevent rapid recovery of nonlisted marine mammals once the impacting agent (i.e., passing aircraft or vessel) was eliminated. It is expected that these impacts would be manifested primarily as avoidance behavior by these species. It is assumed that behavior would return to normal once a vessel or aircraft passed. Therefore, impacts from vessel traffic would be minor.

Operators are required to sever and remove all wells, structures, and equipment within 1 year following termination of a lease. In addition, lessees must verify that the location has been cleared of all obstructions (30 CFR 250.702, 250.704, and 250.913). Some decommissioning operations are common to all types of production facilities and water depths. For example, wells must be plugged and abandoned in accordance with 30 CFR Part 250, Subpart G. Pipelines and umbilicals used with subsea wells and equipment must be cleaned and capped, and may be abandoned in place.

Given the use of large bottom-founded structures in the initial development of deepwater areas, future decommissioning is expected to require the sequential dismantling of sections of each platform jacket, with subsequent shipment to shore. It is also possible that production facilities may be converted to reefs (i.e., rigs-to-reef) or toppled in place and abandoned (USDOI, MMS, 2000b).

The removal of platforms and other structures often requires the use of explosives. Historically in the Gulf of Mexico, about two-thirds of the platforms have been removed using explosives. Impacts of an underwater explosion could include both physical damage resulting from pressure effects and noise-related impacts. Mitigation measures, in the form of general guidelines for explosive platform removals, have been established by MMS, with the cooperation of the USDOC, National Marine Fisheries Service (NMFS). These guidelines require a mitigation plan that uses qualified observers to monitor the detonation area for protected species prior to and after each detonation. The detection of any marine mammal within a predetermined radius from the structure prior to detonation would without exception delay its removal. Sperm whales are not known to be associated with OCS structures, and as long as operators comply with these mitigating measures, it is expected that impacts other than short-term behavioral disturbance would be avoided. The impact would be minor. The same analysis applies to nonlisted species. As long as operators comply with the mitigating measures, it is expected that impacts to nonlisted marine mammals other than short-term behavioral disturbance would be avoided and therefore the impact would be minor.

4.3.2.3.2. Accidents

In the Gulf of Mexico oil-spill sources include pipelines, platforms, and tankers. Spilled oil may affect marine mammals through various pathways: direct contact, inhalation of oil or related volatile distillates, ingestion of oil (directly, or indirectly through the consumption of oiled prey species), and (for mysticetes) impairment of feeding by fouling of baleen (Geraci, 1990). Studies have shown that direct contact of oil with sensitive tissues such as eyes and other mucous membranes produces irritation and inflammation. Cetacean skin may also experience irritation when exposed to oil or petroleum products (e.g., fuels in high concentrations, long exposure) (Geraci and St. Aubin, 1982). However, under less extreme exposures (lower concentrations or shorter durations), oil does not appear to readily adhere to or be absorbed through cetacean skin. Cetacean skin may, therefore, serve somewhat as a barrier to substances such allergenic hydrocarbons in the marine environment (Harvey and Dahlheim, 1994). Nevertheless, cetaceans observed in or within the proximity of surface oil associated with the *Exxon Valdez* spill showed no evidence of avoidance or abnormal behavior when swimming near or within oil. Their lack of response may subject them to increased levels of exposure to spilled surface oil (Harvey and Dahlheim, 1994). Marine mammals surfacing within or near an oil spill may inhale petroleum vapors. Small doses of oil, when aspirated, have been shown to cause acute fatal pneumonia in mammals. Studies on effects of petroleum vapors on terrestrial mammals and seals showed (in cases of prolonged exposures and high concentrations) absorption of hydrocarbons in organs and other tissues, and damage to the brain and central nervous system. However, short-term inhalation of petroleum vapors at concentrations similar to those found in oceanic oil spills may not be necessarily detrimental, either in terms of structural tissue damage or respiratory gas exchange. Ingested oil, particularly the lighter fractions, can be toxic to marine mammals. Ingested oil can remain within the gastrointestinal tract and be absorbed into the bloodstream and thus irritate and/or destroy epithelial cells in the stomach and intestine. Certain constituents of oil, such as aromatic hydrocarbons and PAH's, include some well-known carcinogens. These substances, however, do not show significant biomagnification in food chains and are readily metabolized by many organisms. Spilled oil may also foul the baleen fibers of mysticete whales, thereby impairing food-gathering efficiency or resulting in the ingestion of oil or oil-contaminated prey (Geraci and St. Aubin, 1987). Certain species or stocks of marine mammals may be at greater potential risk from spilled oil, based on their relative exposures. These include those species or stocks that may inhabit or frequent restricted areas such as bays and estuaries (e.g., coastal bottlenose dolphins), or those with particular feeding strategies or a dependence on selected localized habitats for feeding, shelter, or reproduction (e.g., surface-feeding baleen whales and sperm whales off the Mississippi River mouth) (Würsig, 1990).

Sperm whales may also be susceptible to impacts from spilled oil or fuel. They have widespread distribution in the Gulf generally between 100 and 2,000 m, with concentrations within the central Gulf south of the Mississippi River Delta, and the western Gulf east of the Texas-Mexico border. Spilled oil within these areas of sperm whale concentrations could affect this species. The assumed number of deepwater oil spills associated with the proposed action are presented in Table 4-1e. Though the areas of sperm whale concentrations are relatively small, it is possible that spilled oil from a tanker spill in the Central Gulf could reach the sperm whale's preferred habitat prior to weathering. Oil exposure would not persist in the open ocean, and the animals would not come into contact with oiled areas. Impacts from spilled oil on sperm whales would be minor.

Manatees may be susceptible to impacts resulting from oil spilled within coastal waters. These impacts may be direct through contact with spilled oil, or indirect through the destruction of preferred habitats. However, as discussed in Section 3.1.2.1, their distribution in the Gulf of Mexico is primarily limited to coastal waters along the Florida peninsula, with some individuals venturing into coastal waters of the Florida Panhandle and occasionally the central and western Gulf. The assumed oil spills within shallow water associated with the proposed action are presented in Table 4-1e. Since there would be no proposed pipeline landfalls in the Eastern Gulf of Mexico Planning Area, a pipeline oil spill in nearshore or coastal waters there is unlikely. A nearshore pipeline spill in the Central Planning Area and possibly a spill in the eastern Gulf could contact a manatee if the spill were to occur during summer months when some manatees venture into areas of the northern Gulf. Because individual animals might require medical attention and because oiled coastal habitats (e.g., wetlands) could become a chronic source of oiling if not remediated, impacts on manatees from oil spills would be minor to moderate.

Certain species or stocks of nonlisted marine mammals may be at greater potential risk from spilled oil, based on their relative exposures. Deepwater spills may potentially impact the diverse suite of cetacean species that inhabit continental shelf edge and slope habitats. In the case of a potential shallow-water spill within coastal waters, those species or stocks that may inhabit or frequent restricted areas such as bays and estuaries (e.g., coastal bottlenose dolphins) may be at greater risk than more open-water species. Also, those species with particular feeding strategies or a dependence on selected localized habitats for feeding, shelter, or reproduction (e.g., mysticetes that may occasionally feed on the surface or near the surface such as the Bryde's whale) may also be at greater risk (Würsig, 1990). Spilled oil could directly contact and perhaps directly or indirectly affect these species in the Gulf of Mexico. It is not certain whether these animals would avoid areas of spilled oil. Overall, these impacts from oil spill s are expected to be minor to moderate.

The MMS has established stringent requirements for spill prevention and response and has an inspection program to ensure compliance by oil and gas operators. The petroleum industry uses state-of-the-art technology and the most current operating procedures while conducting OCS operations (Appendix C). In addition, the petroleum industry must maintain a continual state of oil-spill response readiness to meet MMS spill-response requirements. The level of oil-spill response is dependent on spill size. Small spills would likely be handled using nearby spill containment and cleanup equipment, whereas larger spills will prompt appropriate mobilization of additional response resources.

Oil-spill response activities that may affect cetaceans involve the application of dispersant chemicals to spilled surface oil. These dispersant chemicals contain toxic constituents that are considered to be low when compared to toxic constituents of spilled oil (Wells, 1989). There are few data sources that detail the effects of oil dispersants or coagulants on marine mammals (Tucker and Associates, Inc., 1990). Oil-spill response equipment and support vessels are also another source of underwater noise. Oil-spill response support vessels may also increase the risk of collisions between these vessels and sperm whales. However, the use of these chemicals and activities are expected to be localized and infrequent. Under conditions where a large spill occurs close to shore, it is possible that shoreline contact may occur, depending upon ambient wind and current conditions. In temperate and subtropical regions (e.g., California, Gulf of Mexico), shoreline cleanup operations may involve crews working with sorbents, hand tools, and heavy equipment. Oiled shorelines may also be washed with warm or cold water, depending upon beach type.

Potential impacts of oil-spill response activities to sperm whales and manatees are expected to be minor. Oil-spill response activities that may affect nonlisted marine mammals (as briefly described above) would consist mainly of temporary behavioral disruption and are considered minor.

Conclusion: Impacts on sperm whales due to routine operations would be **minor**. Impacts on the West Indian manatee due to routine operations are expected to be **negligible**. Potential impacts to nonlisted marine mammals due to routine OCS operations would be **minor**. If a large oil spill were to occur and contact sperm whales or manatees, impacts would be **minor** for the sperm whale and **minor** to **moderate** for the West Indian manatee. Impacts to nonlisted marine mammals due to accidents would be **minor** to **moderate**.

4.3.2.4. Terrestrial Mammals

Routine Operations

The terrestrial mammals that are considered in this section are those threatened or endangered species that may be affected by routine OCS operations or accidents. These include the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice; and the Florida salt marsh vole (see Section 3.1.2.2 and Figure 3-6). The beach mice are limited to mature coastal dune habitats along the Alabama and northwest Florida coasts. These habitats are generally located within protected areas and are buffered from contact with OCS industry infrastructure. The Florida salt marsh vole is found in a coastal salt marsh near Cedar Key, in Waccassa Bay in Levy County, Florida, and would not come into contact with routine operations.

Accidents

Impact producing factors that could affect endangered terrestrial mammal species include the presence of spilled oil and oil-spill response activities within these species' restricted habitats. Direct contact with spilled oil may cause irritation of skin, eyes, and mucous membranes. Asphyxiation may result from the inhalation of toxic fumes (especially aromatic hydrocarbons). In addition, oil may be ingested through contaminated food or through attempts to clean oiled fur. Contact with spilled oil may result in the degradation of these species' preferred or critical habitats and lead to their temporary displacement from or permanent abandonment of these habitats.

A tanker spill fairly close to shore would have the potential to contact beaches adjacent to beach mouse habitat, particularly if a spill were to occur nearshore or within inshore waterways. However, these habitats are small and buffered from direct contact of oil with the shoreline. Beach mice are generally restricted to areas of secondary inshore dune habitats; that is, areas behind primary dunes along exposed sandy beaches. It is not expected that spilled oil released during a shallow water accident would reach these habitats unless the accident occurred during a period of high storm surge.

The habitats of the Florida salt marsh vole and beach mice are over 100 km from the leasing area considered in the Eastern Gulf of Mexico Planning Area and are unlikely to be affected by a spill. Should an oil spill take place and contact nearby coastal areas, oil-spill response activities, including beach cleanup activities and vehicular and pedestrian traffic, could result in the degradation of habitat. However, as these preferred and critical habitats are clearly known, oil-spill contingency plans require that planned beach cleanup activities would minimize impacts to these habitats and focus activities within the intertidal zone of the affected beach

Conclusion: Potential impacts of routine operations or accidents on listed terrestrial mammals would be **negligible.**

4.3.2.5. Marine and Coastal Birds

4.3.2.5.1. Routine Operations

Routine activities that may affect listed bird species in the Gulf of Mexico include structure placement (pipeline landfalls), operational discharges and wastes, and vessel and aircraft traffic.

Marine and coastal birds could be affected by coastal habitat loss or alteration resulting from new OCS pipeline landfalls within the Central and Western Gulf of Mexico Planning Areas. The estimated pipeline mileage, numbers of landfalls, and bottom area disturbed by the proposed action are detailed in Table 4-1a. The effects on marine and coastal birds would depend on the specific location of the landfall, such as whether the landfall may be classified as critical or preferred habitat for activities such as nesting or feeding, and the extent and duration of damage to sensitive inshore habitats. Certain listed species of coastal birds use shoreline Gulf of Mexico habitats during certain seasons of the year. Examples occurring along the shorelines (or adjacent wetlands) of the central and western Gulf are the whooping crane (*Grus americana*), bald eagle (*Haliaeetus leucocephalus*), brown pelican (*Pelicanus occidentalis*), eskimo curlew (*Nominees borealis*), piping plover (*Charadrius melodus*), and snowy plover (*Charadrius alexandrinus*). Loss or alteration of preferred habitat due to new OCS pipeline landfalls could result in the displacement of individual or groups of birds from the impacted area(s), including the possible decrease in nesting activities. However, pipelines in the central and western Gulf of Mexico typically are brought to shore through a directional drilling process. This is an effective mitigation measure for avoiding impacts on coastal habitats because the pipeline passes under them. It is expected that most impacts from the proposed action to coastal habitats supporting both listed and nonlisted marine and coastal birds would be avoided, or the resource would recover quickly if disturbed. Thus, impacts from the proposed action to coastal habitats of marine and coastal birds would be minor.

As briefly discussed in Section 3.1.2.3, birds (including local seabirds, and trans-Gulf migrant birds other than seabirds) commonly use offshore oil and gas production platforms for rest stops or as temporary shelter from inclement weather. For these migrant non-seabird species, it is believed that these platforms may serve a role as artificial islands and may thus facilitate extensions of their natural distributional range and survivability.

Operational discharges include components that may injure marine and coastal birds. Of threatened or endangered bird species discussed in Section 3.1.2.3, it is expected that only the eastern brown pelican would be of concern. The roseate tern (the other listed seabird in the Gulf of Mexico) does not commonly range into the northern Gulf beyond waters near the Florida Keys and is therefore, not expected to be exposed to routine operational discharges. Anticipated impacts from routine OCS operations in the proposed action may occasionally lead to sublethal stress on certain individual seabirds under certain circumstances. This stress may be indirect as a result of the impacts of the discharges on prey species (reduction in prey), or possibly direct, through prolonged exposure to the discharge or through the ingestion of affected prey species (NRC, 1983; API, 1989; Kennicutt, 1995). Based on the rapid dispersion and dilution of discharges, it is expected that operational discharges would have negligible impacts on eastern brown pelicans or other listed seabirds.

As in the case of listed species, anticipated impacts to nonlisted marine and coastal bird species from routine operational discharges in the proposed action may occasionally lead to sublethal stress. This stress may be indirect (e.g. reduction in prey), or possibly direct through prolonged exposure or the ingestion of affected prey species. However, based on the low concentrations of discharged contaminants within an open-ocean environment, it is expected that the impact to nonlisted seabirds would be negligible.

Operational discharges from OCS service and construction vessels have been discussed in Section 4.3.2.3. Because of current regulations regarding the release of discharges from offshore vessels and the anticipated level of vessel traffic and discharge assumed in the proposed action scenario, it is expected that fluid waste discharges from OCS service and construction vessels would have no measurable impact on marine and coastal birds. Impacts would be negligible.

Though the activities associated with the proposed action would be conducted at a distance from shore that would permit the discharge of waste fluids from these OCS service and construction vessels, it is predicted that these wastes would be diluted and dispersed rapidly in the open-ocean environment. With the anticipated level of vessel traffic and discharges predicted in the proposed action, it is expected that the impacts of fluid waste discharges from these vessels would have negligible impacts on listed seabirds.

Marine and coastal birds are susceptible to entanglement with discarded debris. In addition, many species ingest particles of debris. Entanglement with debris commonly leads to damage or loss of limbs, entrapment, or the prevention or hindrance of their ability to fly or swim. Ingested debris may irritate or block the digestive tract, impair digestion of food in the digestive tract, or release toxic chemicals (Fry et al., 1987). However, the discharge or disposal of solid debris from both OCS structures and vessels is prohibited by the MMS (30 CFR 250.40) and the U.S. Coast Guard (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]). As long as operators comply with these regulations, most impacts would be avoided. Individual birds, whether listed or nonlisted, may be injured or killed, but impacts to the resource (population) from discarded debris would be minor.

Helicopter and service vessel traffic could periodically disturb individuals or groups of listed species of coastal or marine birds. These disturbances would pertain to helicopter or service vessel travel within or across sensitive coastal habitats (e.g., wetlands that may support feeding, resting, or breeding birds). The effects of disturbance from helicopter and vessel traffic may be manifested as temporary or permanent displacement of birds from areas such as preferred or critical habitats, including nesting areas. Displacement from active nests may result in nesting failure or may allow the predation of eggs or unfledged young. The level of disturbance to birds generated by helicopter or vessel traffic may be highly variable, based on the bird species, type of vehicle (helicopter, vessel), relative noise level, speed of vessel, altitude and distance of the noise source from the receptor, frequency of occurrence of the disturbance, and season (Bowles, 1995). Federal Aviation Administration guidelines and corporate helicopter operatives request that pilots maintain a minimum altitude of 213 m while in transit offshore, 305 m over unpopulated areas or across coastlines, and 610 m over populated areas and sensitive habitats such as wildlife refuges and park properties. Vessel operators are required to maintain slow, wake-free speeds while transiting across most sensitive inland waterways. These Federal and corporate regulations regarding service altitudes for OCS helicopters and vessel speeds when entering or departing coastal waterways are expected to minimize impacts to nesting or roosting birds within coastal areas. It is assumed that only relatively small proportions of the populations of these species would be exposed. In addition, with the aforementioned guidelines and restrictions in effect, it is likely that individuals would experience only short-term, nonlethal effects (primarily temporary displacement behavior) from these encounters. Impacts from helicopter and service vessel traffic would be minor.

4.3.2.5.2. Accidents

Applicable impact producing factors include the presence of spilled oil and oil dispersant chemicals, and noise and coastal habitat loss or degradation associated with oil-spill response activities.

Spilled oil may affect birds through various pathways. Direct contact with oil may result in the fouling or matting of feathers, with subsequent limited or loss of flight capability and insulating or water repellent capabilities; irritation or inflammation of skin or sensitive tissues such as eyes and other mucous membranes; or toxic effects from ingesting oil or inhaling oil or related volatile distillates (Fry and Lowenstine, 1985). Ingested oil may also depress egg laying activity or may result in the death or deformities of young (Fry et al., 1985; Leighton, 1990). Oil may also be physically transferred by nesting adults to eggs or young. Direct effects of oil contact may be amplified under conditions of environmental stress such as low temperatures, migration movements, and molting. Indirect effects of oil contact include toxic effects from the consumption of contaminated food, or starvation from the reduction of food resources (Lee and Socci, 1989). The latter effects may hinder the recovery of impacted bird populations after a spill (Chapman, 1989; Hartung, 1995; Slater et al., 1995; Piatt and Anderson, 1996; Piatt and Ford, 1996).

Of the large spills assumed in the proposed action (Table 4-1e), those in deep water are not likely to affect listed marine and coastal birds. Brown pelicans, the most common listed seabird species in the Gulf, typically do not venture offshore of the inner continental shelf. The other listed birds would be likely to encounter spilled oil only if it reached coastal habitats. Neither the tanker spill in the Central Gulf of Mexico Planning Area nor the pipeline spill in the Western Gulf of Mexico Planning Area is likely to affect coastal habitats because these are assumed to occur in deep water. Deepwater spills would either be transported away from coastal habitats, or natural weathering processes would prevent most of the oil from reaching coastal habitats.

Both deepwater and shallow-water spills are relevant when discussing impacts to nonlisted marine and coastal birds. Oil spills in deepwater areas could directly impact pelagic seabirds feeding or resting within oil-contaminated waters. The possible numbers of impacted nonlisted seabirds may range from a few scattered individuals to several within local aggregations (e.g., overwintering northern gannets). Impacts from deepwater oil spills would be minor.

Large, shallow-water oil spills are assumed in the proposed action: a pipeline spill and a platform spill in the Central Gulf of Mexico Planning Area and a platform spill in the Western Planning Area. For this analysis, it is also assumed that a pipeline spill in the Eastern Gulf of Mexico Planning Area would occur in shallow water. Brown pelicans could be exposed to shallow-water spills. Other listed species that could be affected include piping plover, snowy plover, and wood stork. Plovers in the Gulf of Mexico are common inhabitants of sandy beaches and exposed sand and mudbar habitats. Here they may be found singly or in small groups or aggregations. It is possible that listed piping and snowy plovers could come in contact with oil if the shallow-water spills were to occur within nearshore waters and subsequently move into these species' preferred coastal habitats. In this scenario, these birds may be directly impacted by the fouling of plumage and skin, subsequent ingestion of oil through preening efforts, or consumption of oil-contaminated prey items, or indirectly by reduced prey densities within the impacted nearshore habitats. Wood storks are common inhabitants of inshore wetland habitats. In the Gulf of Mexico, they occur primarily within Florida. Wood storks would be affected only if a shallow-water pipeline spill were to reach their rather specific preferred wetlands habitats. In this scenario, as in the case of the listed plover species, the wood storks could be directly oiled, ingest oil-contaminated prey items, or encounter reduced prey items within these oiled habitats. Also spills would not be expected to contact or otherwise impact bald eagles unless contamination and subsequent cleanup activities occurred within the vicinity of eagle nesting or roosting sites.

If a large spill in shallow water were to reach coastal waters and shorelines, the possibility exists for relatively large numbers of some listed bird species to contact the spilled oil. Birds could be killed or injured and could require cleaning and medical attention. Cleanup of the affected habitat could be necessary to avoid chronic exposure. However, a spill of 4,600 bbl (or less) probably would not threaten the viability of any listed bird populations. Impacts to listed marine and coastal birds from shallow-water oil spills would be minor to moderate.

Shallow-water oil spills could also contact and thus impact large numbers of nonlisted coastal and marine birds. These would range from primarily shelf-dwelling seabird species (primarily gulls and terns) for spills that may occur (and remain) within inner shelf waters, to a diverse suite of seabird, shorebird, and wetlands bird species for spills that may occur within or reach coastal beaches, embayments, and wetlands habitats.

Certain species of marine and coastal birds may be more susceptible to contact with spilled oil than others, based upon their life histories. For example, diving birds and underwater swimmers such as loons, cormorants, and diving ducks may be the most susceptible to spilled oil because of their relative exposure time within the water and at the sea surface. Shorebirds and wetland birds may also be susceptible to direct oiling if a spill were to reach the beach intertidal zone or inshore wetlands habitats, respectively. The magnitude of the impact would also depend upon the size of the local bird population.

In the case of a large pipeline spill in shallow water, the possibility exists for relatively large numbers of marine and coastal birds to contact spilled oil if it were to reach coastal habitats with high bird abundance before being contained or cleaned up. In such a case, it is reasonable to assume that bird mortality could range in the hundreds of individuals. Birds could require cleaning and medical attention, and cleanup of the affected habitat could be necessary to avoid chronic exposure. However, a spill of 4,600 bbl (or less) probably would not threaten the viability of any nonlisted bird populations, thus, impacts from a spill of this size would be minor to moderate.

Oil-spill response activities that may affect marine and coastal birds involve the application of dispersant chemicals to spilled surface oil. These dispersant chemicals contain constituents that are considered to have low levels of toxicity when compared to toxic constituents of spilled oil (Wells, 1989). The effects of oil dispersants or coagulants on seabirds are poorly known. In addition, coastal cleanup and remediation activities may impact local populations of shorebirds or wetland birds, resulting in their temporary displacement from these impacted areas. This displacement may be significant for areas considered critical or preferred habitat for select species, especially during breeding seasons. As mentioned above, any beach or wetland cleanup methods would be expected to occur only within the central and eastern Gulf and thus may impact brown pelicans, piping plovers, snowy plovers, and wood storks. However, the use of these chemicals and activities would be localized and infrequent. Impacts would consist mainly of short-term behavioral disruption and recoverable damage to coastal habitats; thus impacts from oil-spill response activities to listed and nonlisted marine and coastal birds would be minor.

Conclusion: Impacts on listed and nonlisted marine and coastal birds due to routine OCS operations would be **minor**. Impacts on listed marine and coastal birds due to potential accidents would be **minor** to **moderate**. Impacts on nonlisted marine and coastal birds due to potential accidents would also be **minor** to **moderate**.

4.3.2.6. Fish Resources

4.3.2.6.1. Gulf Sturgeon (Threatened Species)

Routine Operations

The placement of bottom-founded structures during the exploratory drilling phase may impact adult Gulf sturgeon (*Acipenser oxyrinchus desotoi*) directly and indirectly. Installation of seafloor anchors, jack-up rigs, and other mobile offshore drilling units (MODU's) disturb the seafloor, produce turbidity, and crush benthos. The areal extent of these disturbances generally corresponds to the dimensions of each leg and anchor, generally on the order of several hundred to several thousand square meters. These impacts could affect adult Gulf sturgeon during cooler months of the year when they move from coastal rivers into inner shelf waters of the eastern and central Gulf (Continental Shelf Associates, Inc., 1995). This is the primary feeding period for Gulf sturgeon, as feeding activity decreases during the upstream spawning migration (Huff, 1975; Mason and Clugston, 1993). Adult Gulf sturgeon can be expected to move out of an area of installation activity while each phase is completed. Depending upon the amount of disturbance, displaced fish may or may not return. The disruption of benthic invertebrate assemblages could indirectly affect bottom-feeding Gulf sturgeon by temporarily reducing a portion of the available prey base. The main effect would be temporary avoidance or displacement.

Under the proposed action, it has been assumed that explosives would be used to remove from 140 to 250 platforms in the Gulf of Mexico (Table 4-1a). Explosive blasts can be lethal to fishes that may be present near the structure (Gitschlag, 2000). However, the Gulf sturgeon is not known to have an affinity for offshore structures, and thus they are not likely to be affected.

Most operational discharges and wastes are released at or near the sea surface and are diluted and dispersed rapidly in the ocean. Because adult Gulf sturgeon are demersal, direct exposure to these discharges is unlikely. One exception would be drilling muds and cuttings, which settle to the seafloor near drill sites, generally within a few hundred meters (NRC, 1983; Neff, 1987). Although adult Gulf sturgeon are present on the OCS during cooler months of the year when they move from coastal rivers into inner shelf waters of the eastern and central Gulf, they are not known to have an affinity for structured habitat. Thus, they are not likely to be exposed to drilling muds and cuttings accumulations. Studies have shown that no significant bioaccumulation of metals from drilling muds in fishes living near actively discharging platforms (Kennicutt, 1995).

Produced water discharges are unlikely to have measurable impacts on Gulf sturgeon. Although several components of produced water such as trace metals, hydrocarbons, and NORM are potentially toxic to fishes, field studies have shown that levels of these components in fishes collected around discharging platforms are well below background levels (Neff, 1997). Produced water discharges dilute rapidly in the open ocean. Direct exposure to produced water would only occur in the water column near the discharge point. Unlike fishes that have pelagic adults and planktonic eggs and larvae, the Gulf sturgeon is a bottom dweller and its eggs are deposited on the bottom of rivers far removed from produced water discharges making exposure unlikely.

The sources of underwater noise from oil and gas operations include seismic surveying, drilling and production operations, support vessels, helicopter traffic, and decommissioning operations. There is no information on the hearing or acoustic biology of Gulf sturgeon from which to assess effects. Evidence from several other fish species indicates that many fish species can hear sounds within the frequency ranges produced by OCS activities. The magnitude of effects is inversely related to the distance from the source due to attenuation of sound. The only noise sources strong enough to produce impacts other than behavioral disruption are seismic surveys. Since the seismic sources (airguns) are fired in the upper water column, Gulf sturgeon are unlikely to be affected. Adult Gulf sturgeon wintering in shelf waters of the Gulf of Mexico may be affected by sounds emanating from working platforms and their attendant operations. However, the most likely effects would be short-term behavioral disruption or avoidance of certain areas.

Accidents

Pipeline spills are the only accidents in the scenario likely to affect Gulf sturgeon. Pipeline spills in the Eastern and Central Gulf of Mexico Planning Areas are relevant because these are the two regions where Gulf sturgeon occur (Figure 3-7). The proposed action includes two 4,600-bbl pipeline spills potentially occurring in shallow water–one in the Central Planning Area and one in the Eastern Planning Area (Table 4-1e).

Hydrocarbons from spilled oil can affect adult sturgeon by direct contact with gills or via direct ingestion. Toxic fractions of PAH's of spilled oil can cause death or illness in adult fishes, but exposure to these fractions must be continuous. Adult and juvenile fishes should actively avoid a large oil spill; however, the demersal eggs and riverborne larvae would be unable to avoid spilled oil. Eggs and larvae of fishes will die or become deformed if exposed to certain toxic fractions of spilled oil (Longwell, 1977; Carls and Rice, 1990; Collier et al., 1996; Kingsford, 1996). The Gulf sturgeon deposits demersal eggs (which hatch in about 1 week) in freshwater reaches of the major rivers of the eastern and central Gulf of Mexico, usually in deep areas or holes with current flow (Figure 3-7). Floating oil is not likely to penetrate to the middle reaches of most rivers where eggs are deposited because it would float on the freshwater outflow and never reach or settle directly on demersal eggs (Sulak and Clugston, 1998; Fox et al., 2000).

Conclusion: Impacts on Gulf sturgeon associated with routine operations and accidents for the proposed action are expected to be **minor**.

4.3.2.6.2. Other Fish Resources

Routine Operations

Installation of seafloor anchors, jackup rigs, other MODU's, and platforms would disturb the seafloor. The placement of these bottom-founded structures can affect fish resources in several ways. The primary impact factors are sediment disturbance, crushing of benthos (prey for bottom feeding fishes), and increased turbidity due to resuspended sediments. Emplacement of bottom-founded systems disturbs sediments and benthic organisms beneath each jacket leg. The areal extent of the seafloor disturbance corresponds to the dimensions of each jacket leg. Floating production systems produce similar impacts due to mooring anchors, turrets, and any subsea completions.

Hard-bottom areas, and therefore hard-bottom fishes, would probably not be directly affected by facility placement because they are protected by the Live Bottom Stipulation which establishes a "No Activity Zone" in which no operations, anchoring, or structures are allowed. Pelagic and soft-bottom demersal fishes may move out of an area of installation activity. Depending upon the amount of disturbance, displaced fishes may or may not return. The disruption of benthic invertebrate assemblages could indirectly affect bottom-feeding fishes by reducing the available prey base. In either case, affected fish resources would recover without mitigation.

Once put in place, platforms serve as artificial reefs or fish attraction devices (FAD's). For those species preferring bottom relief (e.g., snappers, groupers, spadefish), the presence of additional FAD's is a beneficial impact. In contrast, the physical presence of FAD's in deep water (> 200 m) may indirectly affect populations of highly migratory fish species such as tunas and billfishes by causing changes in feeding and spawning behavior (USDOI, MMS, 1999).

The effects of floating structures on migratory or feeding habits in epipelagic fishes such as tunas and billfishes are not known. However, a fisheries panel expressed concern during a recent MMS-sponsored workshop on deepwater oil and gas activities (Carney, 1997). In response to these concerns, MMS has contracted a study to investigate the problem (e.g., Edwards et al., 2000). Floating structures used in exploration and production and their attendant mooring lines will act as FAD's. In oceanic waters, the FAD effect would be most pronounced for epipelagic fishes such as tunas, dolphin, billfishes, and jacks. These species are commonly attracted to fixed and drifting surface structures (e.g., Holland et al., 1990; Higashi, 1994; Relini et al., 1994). The concern is that these highly migratory species would be diverted from normal migratory routes and, consequently, from normal spawning or feeding areas. Because of the highly migratory nature of many epipelagic species, these effects could extend to the regional scale. Although little is known about their habits, vertically migrating midwater fishes may also be attracted to or repelled by surface structures. The disruption of migrations could result in short- or long-term effects on the feeding behavior of oceanic fishes. The FAD effect mentioned previously would possibly enhance feeding of epipelagic predators by attracting and concentrating smaller prey species. It is possible that persistent regional effects on populations could result, which would be a moderate impact. However, this issue requires further study, as recognized by the MMS, and the possibility of moderate impacts is speculative.

Structures associated with OCS activities can also affect the food resources and feeding behavior of demersal species. Deepwater and shelf fishes that feed on benthos would be displaced from small areas by seafloor structures such as anchors, manifolds, and wellheads. Some minor loss of benthic (epifaunal and infaunal) food items would also occur. The total seafloor area impacted under the proposed action is extremely small, representing only a fraction of the total seafloor available. Displacement would be a recoverable impact because fishes could move to adjacent areas. Localized damage to benthic communities would also recover without mitigation.

The use of explosives to remove bottom-founded platforms can kill or stun most of the fishes associated with the structures (Gitschlag, 2000). Studies conducted at platform removal sites in the central and western Gulf of Mexico by NMFS (Gitschlag, 2000) estimated that between 2,000 and 6,000 fishes were killed during explosive removals in water depths ranging from 14 to 32 m. Sheepshead, spadefish, red snapper, and blue runner accounted for 89 percent of the mortality estimated by these studies. Projections of population-level effects were calculated for red snapper because this is the only species of that group managed by NMFS. The estimates indicated that the overall mortality of red snapper contributed by explosive platform removal, even if doubled, would not add significantly to the mortality estimates already determined for the fished population (Gitschlag et al., 2000). The resource would recover without mitigation.

In situ abandonment of bottom-founded structures such as mooring wires, anchors, and wellheads would likely have an artificial reef or FAD effect on hard-bottom fishes. The direct or indirect impacts of abandonment cannot be determined, given that there is extremely limited information concerning the attraction of deepwater benthic fishes to seafloor structures. By comparison, the removal of structures would eliminate any FAD impacts.

Operational discharges that have the most potential for affecting fishes are drilling fluids (also known as drilling muds) and cuttings and produced water. Water-based drilling fluids and cuttings will increase turbidity levels in the water column but will be localized and temporary. Increased turbidity would cause fish to temporarily move from the area. Synthetic-based drilling fluids (SBF's) will have no effect on fish resources since they cannot be discharged. Cuttings which may have small amounts of SBF's adhered to them are discharged and will also temporarily increase turbidity. This increase will force fishes to leave the area, but they will return. Trace metal and hydrocarbon constituents of drilling fluids can be toxic to all life stages of fishes if exposed to high enough concentrations. Planktonic eggs and larval forms appear to be at greatest risk (e.g., Kingsford, 1996), while juveniles and adults passing through a discharge will not be adversely affected. Research has indicated that SBF cuttings produce an effect related to organic enrichment. At one study site, polychaete densities were over five-fold greater along the more contaminated area, and densities of demersal fishes were higher than observed at other locations. The fish may have been drawn to the area by the disturbed sediments or more exposed benthic food sources. The abundance of the demersal fishes did not seem to have been adversely affected by the discharge of SBF cuttings. Where the highest SBF concentrations were observed, a smaller number of benthic fauna occurred in the more heavily contaminated sediments as compared to the cleaner sediments. This may cause a reduction in some fish species in an area of SBF cuttings if their preferred prey sources were reduced.

Produced water contains several toxic elements such as trace metals, hydrocarbons, and NORM (Neff, 1997). Direct and continuous exposure to produced waters can be lethal to all life stages of fishes. Direct exposure would only occur in the water column near the discharge point, thus pelagic adults and planktonic eggs and larvae are most susceptible. Produced water and domestic discharges could be lethal to early life history stages occurring close to a discharge. Eggs and larvae of fishes are commonly found in the surface waters of the open Gulf (Richards et al., 1989, 1993; Lycozkowski-Schultz, 1999). Higher impacts would be realized if eggs and larvae were unusually concentrated. Thus, local circulation patterns greatly influence the degree of potential impact. Nevertheless, population-level effects would not be likely, given the total volumes expected and the ability of receiving waters to quickly and effectively disperse discharges (i.e., to ambient levels within several thousand meters of the discharge). Produced water discharges are rapidly diluted, and the highest concentrations occur within 10 m of the discharge pipe. Despite the volume of produced water discharged into the Gulf of Mexico, any impacts would be very localized and fully recoverable.

Field studies have shown that the accumulation of trace metals, hydrocarbons, or NORM in the tissues of fishes collected around production platforms was within background levels (Neff, 1997).

All fish species in the northern Gulf are presumed to be able to hear, with varying degrees of sensitivity, within the frequency range of sound produced by exploration, production, and decommissioning activities. These sounds can mask the sounds normally used by fishes. Loud sounds may cause receiving fishes to change their behavior, and their movements may temporarily affect the usual distribution of animals in relation to commercial fishing. Continuous, long-term exposure to high sound pressure levels above 180 decibels (dB) has been shown to cause damage to the hair cells of the ears of some fishes under some circumstances. These effects may not be permanent since damaged hair cells are repaired and/or regenerated in fishes. It seems likely that most fishes exposed to airgun shots at a distance of a few meters could receive inner ear damage as a result of source levels in the range between 210 and 240 dB. As the distance between the fish and the sources increases, the probability of hearing impairment would decrease according to the nature of distance attenuation occurring.

Accidents

Any oil spill in the proposed program areas of the Gulf of Mexico could affect one or more fish populations (Tables 4-1e). Impacts of spilled oil differ among various life stages of fishes. Hydrocarbons from spilled oil can affect adult fishes by direct contact with gills or presence in the gut after swallowing spilled oil. Toxic fractions (PAH's) of spilled oil can cause death or illness in adult fishes, but exposure to these fractions must be continuous. Adult and juvenile fishes should actively avoid a large oil spill; however, the planktonic eggs and larvae would be unable to avoid spilled oil. Eggs and larvae of fishes will die if exposed to certain toxic fractions of spilled oil. Most of the fishes inhabiting shelf or oceanic waters of the Gulf of Mexico have planktonic eggs and larvae (Ditty, 1986; Ditty et al., 1988; Richards et al., 1989, 1993). Although some common groups such as damselfishes and triggerfishes deposit demersal eggs, the newly hatched larvae take up residence in the water column. These early life history stages are not likely to be adversely affected under the proposed action. Impacts would be potentially greater in areas where local scale currents retained planktonic larval assemblages and the floating oil slick within the same water mass. All impacts of small spills are expected to be negligible or minor. Due to the wide dispersal of early life history stages of fishes in the surface waters of the Gulf of Mexico, the impacts of large spills are expected to be minor.

Conclusion*:* Impacts on other fish resources associated with routine operations and accidents for the proposed action are expected to be **minor**.

4.3.2.7. Sea Turtles

4.3.2.7.1. Routine Operations

Applicable impact producing factors of the proposed action include structure placement and removal, operational discharges and wastes, vessel and aircraft traffic, and noise.

Pipeline trenching and construction of pipeline landfalls may affect sea turtles. There is some chance of direct impacts during trenching, because turtles have been known to be killed or injured during dredging operations (Dickerson, 1990; Dickerson et al., 1992). In addition, there may be indirect impacts due to disruption of small corridors of nearshore and coastal habitats. It is assumed that habitats such as seagrass beds and live-bottom areas commonly used by turtles for feeding or resting would be avoided during pipeline routing. It is also assumed that disruption of damage to nesting beaches would be avoided by directional drilling of up to 10 pipeline landfalls in the central and Western Gulf of Mexico. Some soft-bottom areas would be affected by pipeline trenching but would recover without mitigation. Overall, direct and indirect impacts to sea turtles due to pipeline trenching and landfalls would be minor.

Sea turtles can be killed or injured during explosive platform removals (Klima et al., 1988; Gitschlag and Herczeg, 1994). Over the 40-year period of the proposed action, 140 to 250 platforms could be removed by explosives in the central and western Gulf of Mexico. Impacts could include physical damage resulting from pressure effects and noise-related impacts. Mitigation measures, in the form of general guidelines for explosive platform removals, have been established by MMS, with the cooperation of NMFS. These guidelines require a mitigation plan that uses qualified observers to monitor the detonation area for protected species prior to and after each detonation. The detection of sea turtles within a predetermined radius from the structure prior to detonation would, without exception, delay its removal. As long as operators comply with these mitigating measures, it is expected that impacts other than short-term behavioral disturbance would be avoided. Therefore, impacts from explosive platform removals would be minor.

Operational discharges include components that may injure sea turtles. However, rapid dilution after discharge is assumed to minimize impacts on sea turtles. Similarly, discharges of waste fluids from OCS service and construction vessels would be diluted and dispersed rapidly in the open-ocean environment. Assuming compliance with NPDES permits (e.g., limitations on concentrations of toxic constituents) and U.S. Coast Guard regulations, impacts from operational discharges and wastes would be negligible.

Ingestion of, or entanglement with, accidentally discarded solid debris may adversely impact sea turtles. Reports of the ingestion of plastic and other nonbiodegradable debris exist for almost all sea turtle species and life stages. Ingestion of plastic debris can affect the alimentary canal or remain within the stomach. Sublethal quantities of ingested plastic debris can result in various effects including positive buoyancy, in certain turtles, making them more susceptible to collisions with vessels or increasing predation risk (Lutcavage et al., 1997). Certain species of adult sea turtles, such as loggerheads and leatherbacks, appear to readily ingest certain plastic debris. In oceanic waters, floating or subsurface translucent plastic material and sheeting may be mistaken for gelatinous prey items such as jellyfish and siphonophores. Entanglement in plastic debris can result in reduced mobility, drowning, and constriction of and subsequent damage to limbs (Lutcavage et al., 1997). Currently, the discharge or disposal of solid debris from both OCS structures and vessels is prohibited by the MMS (30 CFR 250.40) and the U.S. Coast Guard (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]). Assuming that operators comply with these regulations and laws, most impacts on sea turtles resulting from solid debris would be avoided. Individual turtles may be injured or killed, but impacts to the resource (population) would be minor.

Sources of airborne and underwater noises associated with routine OCS operations have been briefly discussed in Section 3.1.1.5. Sources and characteristics are summarized in Table 4-1a. Unfortunately, studies involving sea turtle hearing sensitivity or noise-induced stress are limited (Ridgway et al., 1969; Bartol et al., 1999); therefore, a full understanding of the physical and behavioral effects of these impact producing factors on these species is not well known (Geraci and St. Aubin, 1987). Sources discussed here are seismic surveys, drilling and production activities, and vessels and aircraft. Explosive structure removals are discussed above as a separate impact factor.

Noise associated with seismic surveys may affect sea turtles. Sounds produced during seismic surveys possess both high- and low-frequency energy that is expected to be detectable by sea turtles. Most energy in seismic pulses is below 200 Hz, while higher frequency components are also present. These sounds are also of much greater energy than other nonexplosive OCS-related sounds. Experiments have been done using airguns to try to repel turtles to avoid hopper dredges, with inconclusive results (O'Hara and Wilcox, 1990; Moein et al., 1995). Impacts of seismic surveys are considered to be primarily sublethal to sea turtles and would probably elicit short-term behavioral responses, such as surfacing and/or temporary displacement, from individual turtles in the vicinity of the survey. Therefore, impacts from noise associated with seismic surveys would be minor.

Offshore drilling and production structures produce a broad array of sounds at frequencies and intensities that may be detected by sea turtles within the area of the installation (Geraci and St. Aubin, 1987). As detailed in Section 3.1.1.5, these sounds are of relatively low frequencies, typically between 4.5-30 Hz, and are relatively weak in intensity (Richardson et al., 1995a). Potential impacts on sea turtles may include behavioral disruption and temporary or permanent displacement from the area near the sound source. Up to 320 new platforms could be installed in the Gulf of Mexico under the 40 years of the proposed action. Certain sea turtles, especially loggerheads, may be attracted to OCS structures and thus may be more susceptible to impacts from sounds produced during routine operations. Overall impacts to sea turtles from noise associated with offshore drilling and production would be minor.

Helicopters and service and construction vessels may affect sea turtles due to machinery noise and/or visual disturbances (NRC, 1990). Sounds from helicopters and vessels would originate from coastal ports and travel through broad areas of the continental shelf and slope. Therefore, the effects of sound generated from these activities could affect any species and life stage of sea turtles known to occur in the Gulf of Mexico. The most likely impacts would be short-term behavioral changes such as diving and evasive swimming, disruption of activities, or departure from the area of disturbance. Areas with heavy vessel traffic may be avoided by sea turtles, although generally most species appear to exhibit considerable tolerance to ship and aircraft noise. Noise related to OCS helicopter and vessel traffic in the Gulf is transient and generally not at levels that would prevent rapid recovery of sea turtles once the source (i.e., passing aircraft or vessel) was eliminated. Therefore, impacts from noise related to helicopter and vessel traffic would be minor.

There is no direct evidence of OCS vessel collisions with sea turtles (of any life stage) in the Gulf of Mexico. However, due to the large number of vessel trips associated with routine operations of the proposed action (Table 4-1a), there is a chance of collision between OCS service vessels and sea turtles. The risk would vary depending upon location, vessel speed, and visibility. Most sea turtles are distributed within nearshore waters and waters of the continental shelf. Sea turtles in all life stages are present throughout the Gulf of Mexico. During the hatching season, it is believed that hatchling turtles leave their nesting beaches and swim offshore to areas of water mass convergence. At this stage these small turtles, even in relative concentrations, would be very difficult to spot from a moving vessel. Similarly, juvenile turtles may be associated with these convergence zones, especially within patches or mats of floating *Sargassum* algae, and may be difficult to spot from a moving vessel because of their small size and generally cryptic coloration patterns, which blend in with the color and patterns of the floating *Sargassum*. Adult turtles are generally visible at the surface during periods of daylight and clear visibility. However, they may also be very difficult to spot from a moving vessel when resting below the water surface, and during nighttime and periods of inclement weather. The Sea Turtle Stranding and Salvage Network (NMFS, Southeast Fisheries Science Center) maintains detailed records of stranded turtles, including their possible causes of death, and documents evidence of injuries and trauma. These include wounds made by moving propellers and broken carapaces, which are believed to be a result of vessel strikes (S. Epperly, NMFS, oral commun., 2001). Although adult, and perhaps juvenile, turtles are capable of avoiding moving vessels, it is possible that collisions between OCS service vessels and sea turtles may occur under certain circumstances.

Individual turtles may be injured or killed, but impacts to the resource (population) from collisions with OCS service vessels would be minor.

4.3.2.7.2. Accidents

Applicable impact producing factors include the presence of spilled oil and oil dispersant chemicals, and noise associated with oil-spill response activities.

As in the case of marine mammals, spilled oil may affect sea turtles through various pathways: direct contact, inhalation of oil or related volatile distillates, ingestion of oil (directly, or indirectly through the consumption of oiled prey species), and ingestion of floating tar (Geraci, 1990). Studies have shown that direct contact of oil with sensitive tissues such as eyes and other mucous membranes produces irritation and inflammation. Oil can adhere to turtle skin or shells; however, no evidence of resultant tissue damage exists. Turtles surfacing within or near an oil spill may inhale petroleum vapors. Small doses of oil, when aspirated, have been shown to cause acute fatal pneumonia in mammals. Studies on effects of petroleum vapors on terrestrial mammals and seals showed (in cases of prolonged exposures and high concentrations) absorption of hydrocarbons in organs and other tissues, and damage to the brain and central nervous system. However, short-term inhalation of petroleum vapors at concentrations similar to those found in oceanic oil spills may not be necessarily detrimental either in terms of structural tissue damage or respiratory gas exchange. Sea turtles have shown apneic response when confronted with disagreeable odors and may thus be able to minimize their exposure to inhaled petroleum vapors. Ingested oil, particularly the lighter fractions, can be toxic to sea turtles. The oil may remain within the gastrointestinal tract and may be absorbed into the bloodstream and thus irritate and/or destroy epithelial cells in the stomach and intestine. Certain constituents of oil, such as aromatic hydrocarbons and PAH's, include some well-known carcinogens. These substances, however, do not show significant biomagnification in food chains and are readily metabolized by many organisms. Hatchling and juvenile turtles feed opportunistically at or near the surface in oceanic waters, and are especially sensitive to spilled oil and oil residues such as floating tar (Lutz and Lutcavage, 1987; Lutcavage et al., 1995). Tar found in the mouths of turtles may have been selectively eaten or ingested accidentally while feeding on organisms or vegetation bound by tar (Geraci and St. Aubin, 1987; Geraci, 1990). Certain species of sea turtles may be at greater potential risk from spilled oil, based on their relative exposures. These include those species or stocks such as loggerheads or Kemp's ridleys, that may inhabit or frequent restricted areas such as bays and estuaries. Spilled oil may also affect sea turtle life stages that show some dependence on selected localized habitats for feeding, shelter, or reproduction, such as post-hatchlings in offshore debris lines (convergence zones) (B.E. Witherington, Florida Marine Research Institute, Melbourne Beach, FL, oral commun., 2000).

Oil spills in shallow water associated with the proposed action are detailed in Table 4-1e. They include two pipeline and two platform spills. As most sea turtles in the Gulf of Mexico are distributed within waters of the continental shelf, it is probable that some individuals would come into contact with spilled oil from these sources. The pipeline spills in the northern parts of the Central and especially the Eastern Gulf of Mexico Planning Areas could also contact a sea turtle nesting beach if the spill were to occur near nesting beaches during the spring and summer nesting season.

The deepwater oil spills assumed under the proposed action include two pipeline spills and one tanker spill (Table 4-1e). As mentioned above, most adult turtles are distributed along the continental shelf. However, leatherbacks and some loggerheads are also regularly sighted within deepwater areas over the continental slope. In addition, juvenile turtles are regularly found within convergence zones in deepwater areas. Although the relative numbers of turtles within the deepwater Gulf are relatively small when compared to the continental shelf, it is possible that individuals may come into contact with these sources of spilled oil. It is possible that some individuals may not recover from such exposure. However, the viability of sea turtle populations as a whole would not be threatened. Overall, the impacts from oil spills would be moderate.

Oil-spill response activities that may affect sea turtles involve the application of dispersant chemicals to spilled surface oil. These dispersant chemicals contain constituents that are considered to be low in toxicity when compared to toxic constituents of spilled oil (Wells, 1989). There are, however, little available data regarding the effects of oil dispersants or coagulants on sea turtles (Tucker and Associates, Inc., 1990). Oil-spill response equipment and support vessels are also another source of underwater noise (see Section 3.1.1.5), and may increase the risk of collisions between these vessels and sea turtles. In addition, beach cleanup and remediation activities may affect sea turtle nests. However, the use of these chemicals and activities is expected to be localized and infrequent. Shoreline cleanup operations may involve crews working with sorbents, hand tools, and heavy equipment. The most likely impacts are temporary behavioral disruption, avoidance, etc. Impacts from oil-spill response activities would be minor.

Conclusion: Potential impacts on sea turtles due to routine OCS operations would be **minor**. If large oil spills were to occur and contact sea turtles, impacts to sea turtles would be **minor** to **moderate**.

4.3.2.8. Coastal Habitats

4.3.2.8.1. Coastal Barrier Beaches and Dunes

Routine Operations

During routine operations, the only factors likely to affect barrier beaches and dunes are pipeline landfalls and vessel traffic. These impacts would occur only in the Western and Central Gulf of Mexico Planning Areas. Up to five new pipeline landfalls in each of these planning areas could result from the proposed action; there would be none in the eastern program area. Although pipeline landfalls can destroy or damage beaches and dunes, pipelines in the central and western Gulf of Mexico typically are brought to shore through a directional boring process. This is an effective mitigation measure for avoiding impacts on coastal habitats (such as barrier beaches and dunes, or wetlands) because the pipeline passes under them.

Over time with a large number of vessel trips, vessel wakes can erode shorelines along inlets, channels, and harbors. The numbers of vessel harbor entrances and exits per year as a result of the proposed action (to continue over the life of the fields to be developed) are as follows (calculated from Table 4-1a):

- Eastern Planning Area–400 to 800
- Central Planning Area–18,200 to 36,400
- Western Planning Area–6,200 to 10,400

Accidents

The potential exists for significant damage to coastal habitats if an oil spill were to reach these areas. Impacts could result from both the contamination of the shoreline with oil and the mechanical damage sustained during the cleanup process. It would be most likely that large, shallow water spills (Table 4-1e) could affect coastal habitats. The proposed action could result in a pipeline spill (4,600 bbl) and a platform spill (1,500 bbl), both in the Central Planning Area, and a platform spill of similar size in the Western Planning Area. A pipeline spill (4,600 bbl) in the Eastern Planning Area might occur in shallow water. Spills occurring in deep water are not likely to affect coastal habitats because of their distance from the coast. Deepwater spills would either be transported away from coastal habitats, or natural weathering processes would prevent most of the oil from reaching coastal habitats.

Barrier beaches and dunes are high-energy habitats where oil is unlikely to persist. The constant movement of sand on and off shore, as well as the continuous winnowing of fine sediments by wave action, tends to remove residual hydrocarbons following spill cleanup. In contrast, oil is more difficult to clean up and is likely to persist in fine sediments associated with wetlands. Wetlands also include numerous plant and animal species that are sensitive to oiling.

Barrier beach and dune habitats, due to their physical setting, have a greater potential for resource recovery than wetlands and would probably recover without mitigation, although proper remedial action would aid recovery. Small oil spills (Table 4-1e) probably would produce little or no lasting impact on barrier beaches and dunes.

4.3.2.8.2 Wetlands

Routine Activities

The proposed action could result in as many as three new shore bases in the Western Gulf of Mexico Planning Area and one in the Central. In addition, two new waste facilities in the Western Planning Area and four in the Central Planning Area could be required. It is assumed that the new shore bases and waste facilities would be constructed in existing developed or upland areas and that they would not be sited in coastal habitats such as barrier beaches or wetlands.

There are no existing shore bases in the Eastern Gulf of Mexico Planning Area (the closest are several along the western and northern edge of Mobile Bay; Figure 3-16), and no new shore bases are likely to be sited there. Service vessels working in the Eastern Planning Area would most likely be based at shore bases in Louisiana. There should be no routine support vessel traffic in the harbors, channels, or waterways of the Eastern Planning Area and, therefore, no impacts on coastal habitats. Impacts in the Central and Western Planning Areas would be reduced by standard erosion prevention measures along inlets, harbor mouths, and channels, and by speed and wake restrictions in harbors and channels. Any impacts would be of more concern in the Central Planning Area because that area is already experiencing a high rate of coastal wetland loss.

Accidents

Impacts from oil spills on coastal or estuarine wetlands would depend upon the size and specific location of the oil spill and the effectiveness of cleanup procedures. Impacts could include death of wetland vegetation and associated fauna; oil saturation and trapping by vegetation and sediments (thus becoming a chronic source of pollution); and mechanical destruction of the wetland area during cleanup. Areas where coastal wetlands front directly on the open Gulf, such as are seen in the Eastern and Central Planning Areas, are particularly vulnerable to spilled oil (Figure 3-9). Some areas may recover completely if proper remedial action were taken. Others may not recover completely, but overall the viability of the wetland resource would not be threatened. Although coastal wetlands might be affected by small spills, it is assumed they would recover without mitigation.

Conclusion: Potential impacts on coastal habitats including beaches and dunes, and wetlands from routine operations would be **minor**. Overall impacts of oil spills on barrier beaches and dunes would be **minor**. If a large oil spill in shallow water were to come ashore and prompt and effective oil-spill containment and cleanup procedures were implemented, the resource would be expected to recover completely. In contrast, if a large oil spill in shallow water were to reach coastal wetlands in any of the Gulf of Mexico planning areas, there would be a reasonable possibility these resources may not fully recover even if remedial action is taken. However, the overall viability of the wetland resource would not be threatened. Impacts would be **minor** to **moderate**. Spills in deep water, further from shore, would not be likely to reach coastal habitats.

4.3.2.9. Seafloor Habitats

4.3.2.9.1. Topographic Features

Topographic features or banks in the Western and Central Gulf of Mexico Planning Areas support sensitive hard-bottom species including corals, coralline algae, sponges, and reef fishes. The features are scattered along the shelf break off the coasts of Texas and Louisiana (see Figure 3-10).

Routine Operations

Factors associated with routine operations that could potentially affect topographic features communities are placement and removal of structures, and operational discharges. However, most impacts would be avoided due to existing mitigation measures, as discussed below. Therefore, a detailed analysis of impacts from these operations is not necessary.

A Topographic Features Stipulation has been in effect for specific lease blocks near these features since 1973. The stipulation establishes a "No Activity Zone" in which no operations, anchoring, or structures are allowed. Within 1,000 m of banks containing the low reef-building antipatharian-transitional zone, all drilling muds and cuttings must be shunted to within 10 m of the seafloor. Banks containing the algal-sponge zone require a shunting zone extending out 1 nautical mile for exploratory drilling, with a 3-mile zone required for shunting of drilling cuttings and fluids from development operations. This stipulation has been very effective in protecting the topographic feature communities, as documented by Rezak et al. (1983, 1985).

Accidents

Of the oil spills assumed to occur in the proposed action scenario, only the two 4,600-bbl pipeline spill in deep water in the Central and Western Gulf of Mexico Planning Areas could affect topographic features (Table 4-1e). Other large spills are at the surface or in shallow water. Oil from surface spills can penetrate the water column to documented depths of 20 m; however, at these depths, it is at concentrations several orders of magnitude lower than those demonstrated to have an effect on marine organisms. Due to the water depths of the topographic features, it is unlikely that any significant amounts of oil from surface spills would reach the sensitive communities.

Pipeline spills from outside the No Activity Zones could reach the vicinity of a topographic feature. However, because of the depth of the banks, the biota probably would not be affected by the subsurface oil. With the crests of all the banks being at least 15 m below the surface, the concentrations of any oil driven to at least this depth would be far below that capable of causing an impact. Due to rapid dilution, subsurface oil spills would have to come into contact with a bank feature almost immediately to have any detrimental impact. Because the topographic features are distributed over a wide area of the shelf edge, the likelihood of any one subsurface spill reaching more than one feature would be minimal. Furthermore, the water currents moving around the banks would carry the spill components around the banks rather than directly over the features, lessening the severity of the impact (Rezak et al., 1983). Analyses of the potential effects of oil spills near banks indicated that, under worst-case conditions, crude oil reaching the biota of banks would be unlikely to be directly lethal to corals and most of the other biota present on the bank (Continental Shelf Associates, Inc., 1992c, 1994b). Any impacts associated with a spill reaching sensitive biota would most likely be sublethal, with recovery occurring within an estimated 2 years. Impacts would therefore be minor.

The use of dispersants on oil spills in the vicinity of the topographic features could cause these compounds to reach the deeper reef areas. However, studies indicate the effect of chemically dispersed oil on corals is no different from the effect of oil alone (Dodge et al., 1984; Wyers et al., 1986). Knap et al. (1985) found that when *Diploria strigosa*, a common massive brain coral at the Flower Garden Banks, was dosed with oil it rapidly exhibited sublethal effects, but also recovered quickly. Again, effects would be minor.

Conclusion: Potential impacts on benthic communities associated with topographic features due to routine operations under the proposed action would be **negligible**. Topographic features are sensitive to physical damage (e.g., by placement of structures or anchors) and operational discharges (e.g., drilling muds and cuttings). However, impacts would be avoided due to the Topographic Features Stipulation and the establishment of No Activity Zones. Potential impacts on benthic communities associated with topographic features due to accidents under the proposed action would be **minor**.

4.3.2.9.2. Live Bottoms and Pinnacle Trend

Routine Operations

Live bottom areas are located primarily on the continental shelf offshore west Florida, in the Eastern Gulf of Mexico Planning Area (Section 3.1.2.7.2). The pinnacle trend is located along the shelf edge offshore of Mississippi and Alabama (Central and Eastern Gulf of Mexico Planning Areas). Factors potentially affecting these areas include placement and removal of structures and operational discharges and wastes.

Protective lease stipulations exist for these areas. The stipulation for the Eastern Gulf of Mexico Planning Area requires a bathymetric and video/photographic survey of the bottom within a minimum 1,000-m radius of a proposed activity site in blocks with water depths of 100 m or less. If live bottom communities were present, the lessee may be required to relocate operations, shunt all drilling fluids and cuttings to the bottom or transport them to shore for disposal, or monitor impacts. A Live Bottom Stipulation has been in effect on leases in the eastern Gulf since 1976.

The Live Bottom (Pinnacle Trend) Stipulation, which applies to certain blocks in the Central and Eastern Gulf of Mexico Planning Areas, requires a bathymetric survey to determine whether pinnacle features are present. Since the pinnacle trend area is subject to high levels of natural sedimentation and turbidity, the stipulation does not contain any specific measures to protect the pinnacles from operational discharges. Operators may be required to relocate operations to avoid damaging hard-bottom communities when anchoring or placing structures.

The installation of MODU's or production platforms on the seafloor, and associated anchoring activities, would crush any organisms under the legs supporting the structure. Placement of structures and anchors in live bottom areas could damage the benthic community. However, the Live Bottom and Pinnacle Trend Stipulations are assumed to be effective in avoiding most physical disturbances from anchoring and placement of structures. Damaged areas would eventually recover over a period of years. Impacts therefore would be minor.

Pipeline placement and removal could impact live bottom communities through resuspension of sediments and burial of organisms. The resuspended sediments could bury sessile invertebrates or clog filter-feeding mechanisms. The pipeline and support ship anchoring activities could also cause physical damage to the hard-bottom structure in live bottom communities. The Live Bottom and Pinnacle Trend Stipulations are assumed to be effective in preventing direct physical disturbance of the these communities by pipeline placement, limiting impacts to the resuspension of sediments. Although some impacts may not be avoidable, the resuspension of sediments would be of short duration, and the resource would recover without mitigation (minor impact).

Explosive platform removals disturb the seafloor and could affect nearby live bottom communities through resuspension of sediments. Deposition of resuspended sediments could smother and kill some sessile animals near the site. Most impacts to live bottom and pinnacle trend areas would be avoided because the existing stipulations would preclude placing structures on or near these communities. Damaged areas would eventually recover over a period of years. Therefore, impacts would be minor.

The discharge of drilling muds and cuttings could cause increased turbidity and localized deposition of sediments on the seafloor. Discharges of muds and cuttings in the vicinity of pinnacle and medium- to higher-relief hard-bottom communities in the central and northeastern Gulf of Mexico are not likely to significantly affect the biota. These communities are usually adapted to life in somewhat turbid conditions and are often observed coated with a sediment veneer (Continental Shelf Associates, Inc. and Texas A&M University, Geochemical and Environmental Research Group, 2001). The existing bottom currents would also prevent the accumulation of large amounts of muds and cuttings. Additional deposition and turbidity caused by a nearby well should not significantly affect the live bottom areas, since discharges are rapidly dispersed and there is little biological effect, except very close to the discharge point. In the pinnacle region, discharges have been measured to reach background levels within 1,500 m of the discharge point (Shinn et al., 1993). Documentation of an exploratory well adjacent to hard bottom in the pinnacle trend at a depth of 103 m, 15 months after drilling showed cuttings and other debris covering an area of approximately 0.6 hectares (ha) (Shinn et al., 1993). The hard-bottom feature was found to support a diverse community including gorgonians, sponges, ahermatypic stony corals, and antipatharians.

The discharge of muds and cuttings in the vicinity of low-relief hard-bottom features with associated live bottom could have a more significant impact if the hard bottom and biota were covered by the sediments. Due to the lower vertical relief, there would be a higher likelihood of at least localized burial of live bottom communities. This would be limited to areas in the immediate vicinity of the discharge point and would be more severe in shallower sites where there would be less spreading of the discharge. Most impacts of drilling muds and cuttings discharges would be avoided due to (1) the Live Bottom Stipulation requiring avoidance of live bottom areas; and (2) NPDES permit restrictions that apply to operations near live bottom areas. Impacts would be minor.

Produced water discharges could impact the biota of pinnacles and hard-bottom features due to sediment contamination with moderate amounts of petroleum hydrocarbons and metals. This would be minimized by limitations in the NPDES permits as well as by the Live Bottom Stipulation, which will prevent the placement of oil and gas platforms in the immediate vicinity of live bottom areas or pinnacle features. The depth of the pinnacle features and live bottom areas, prevailing current speeds, and offsets of the discharges from the live bottom areas will also cause the produced waters to be diluted prior to coming into contact with sensitive biological communities. As a result, the impact of these discharges would be minor.

Accidents

Relevant spills in the proposed action scenario (Table 4-1e) are two pipeline spills (4,600 bbl) in shallow water, one in the Central Gulf of Mexico Planning Area and one in the Eastern Gulf of Mexico Planning Area. Other spills are in deep water or are assumed to occur at the surface with little chance of affecting benthic communities. Small spills (Table 4-1e) also are assumed to occur at the surface and would have no benthic effects.

Most impacts would be precluded by avoiding live bottom and pinnacle areas when siting platforms and pipelines. If a large oil spill from a pipeline were to occur near a pinnacle or live bottom area, the biota could be affected. There could be lethal effects to localized areas, but once the feature was clear of oil, the community would recover without mitigation. In most cases, the effects to sensitive biota would be sublethal, with recovery occurring within months to a few years. Impacts would be minor.

Conclusion: Impacts on live bottom and pinnacle trend communities in the Central and Eastern Gulf of Mexico Planning Areas due to routine activities and large spill accidents under the proposed action would be **minor**.

4.3.2.9.3. Submerged Seagrass Beds

Routine Operations

Most of the seagrass beds in the Gulf of Mexico are located off the coast of Florida (Section 3.1.2.7.4) Factors potentially affecting submerged seagrass beds are placement of structures (pipelines) and vessel traffic. These impacts can be minimized or avoided through the implementation of proper mitigation.

The proposed action scenario includes five pipeline landfalls each in the Central and Western Gulf of Mexico Planning Areas. Pipelines passing through coastal waters would be buried, with the trenching operations disturbing and displacing bottom sediments and producing turbidity along pipeline corridors. It is assumed that seagrass beds would be avoided in the routing of pipeline corridors through coastal and estuarine waters. Turbidity generated during pipeline trenching probably would produce negligible impacts on seagrasses.

Support vessel traffic in coastal waters can disturb submerged seagrass beds. However, existing measures, including use of navigation channels and speed limits in inland waterways, would avoid most impacts. Impacts would be minor.

Accidents

Submerged seagrass beds could be damaged if an oil spill were to reach coastal waters. Three large, shallow water spills in the proposed action scenario (Table 4-1e) could affect submerged seagrass beds: a pipeline spill (4,600 bbl) and a platform spill (1,500 bbl), both in the Central Gulf of Mexico Planning Area, and a pipeline spill (4,600 bbl) in the Eastern Gulf of Mexico Planning Area. It is assumed that neither the tanker spill (5,300 bbl) in the Central Gulf of Mexico Planning Area nor the pipeline spills (4,600 bbl) occurring in deep water in the Central and Western Gulf of Mexico

Planning Areas are likely to affect seagrass beds because of their depth. It is assumed that the deepwater spills would either be transported away from coastal habitats, or that natural weathering processes would prevent most of the oil from reaching the coast.

Impacts on submerged seagrass beds would depend upon the size and specific location of the oil spill and the effectiveness of cleanup procedures. Seagrass beds include numerous plant and animal species that are sensitive to oiling. Impacts could include death of seagrasses and associated fauna; oil saturation and trapping by vegetation and sediments (thus becoming a chronic source of pollution); mechanical destruction of seagrass beds during cleanup; and impacts due to the settling of flocculate if dispersants were used to treat oil on the ocean surface. Oil reaching seagrass beds would be difficult to clean up and would be likely to persist in fine sediments and vegetation. Some areas may recover completely if proper remedial action were taken. Others may not recover completely, but overall the viability of the resource would not be threatened by a spill of 4,600 bbl (or less). Therefore, the impact would be minor to moderate.

Small oil spills (Table 4-1e) could affect submerged seagrass beds, although it is assumed they would recover without mitigation (minor impact).

Conclusion: Impacts on submerged seagrass beds due to routine operations under the proposed action would be **minor,** and overall impacts of oil spills contacting submerged seagrass beds would be **minor** to **moderate**.

4.3.2.9.4. Chemosynthetic (Seep) Communities

With the exception of a single known site on the Florida Escarpment in the eastern Gulf, known Gulf of Mexico chemosynthetic community sites are located in the Central and Western Planning Areas (Figure 3-11). However, it is presumed that such communities could be located virtually anywhere on the continental slope of the northern Gulf of Mexico.

Routine Operations

Impact producing factors from routine operations that could affect chemosynthetic communities are structure placement and removal, and operational discharges. Most impacts would be avoided due to existing mitigation measures.

Existing mitigation measures include Notice to Lessee (NTL) 2000-G20, which requires lessees operating in water depths greater than 400 m to avoid seafloor disturbing activities within 76 m of areas that might support chemosynthetic communities (e.g., as indicated by geophysical data). These requirements are believed to be effective in identifying and avoiding areas of chemosynthetic communities, but it is possible that some lower density chemosynthetic communities would not be identified.

Chemosynthetic communities could be damaged due to anchoring and placement of structures (rigs, platforms, subsea wellheads, and pipelines) on the seafloor. However, the existing mitigation measures are assumed to be effective in avoiding most impacts. Chemosynthetic communities are spread throughout the deep areas of the northern Gulf of Mexico, which makes it unlikely that the damage to small areas of the bottom would threaten this resource as a whole. Affected sites could be repopulated from nearby undisturbed areas, although the rate of recovery could be slow (Macdonald, 2000). Impacts would be minor.

Chemosynthetic communities could be buried or stressed by drilling muds and cuttings discharges. However, in water depths where these communities are found, drilling muds and cuttings deposits would be spread across much wider areas of the seafloor than in shallow sites on the continental shelf. The NTL 2000-G20 prohibits drilling muds and cuttings discharges within 457 m of areas that might support chemosynthetic communities. This makes it unlikely that chemosynthetic communities would be affected by these discharges. Impacts would be minor.

Accidents

The only spill assumed in the proposed action scenario that would be relevant to chemosynthetic communities would be two pipeline spills of 4,600 bbl in the deep water of the Central and Western Gulf of Mexico Planning Areas (Table 4-1e). Other spills are in shallow water or would occur at the surface.

Existing mitigation measures are assumed to be effective in avoiding most impacts by ensuring that pipelines are not routed through or near chemosynthetic communities. Although petroleum hydrocarbons serve as a nutrient source for symbiotic microorganisms associated with macrofaunal species comprising the chemosynthetic communities, a large spill on the seafloor could have adverse impacts on the biota. Communities are assumed to recover without mitigation. Impacts would, therefore, be minor.

Conclusion: Impacts on chemosynthetic communities due to routine operations and oil-spill accidents under the proposed action would be **minor**.

4.3.2.9.5. Other Benthic Communities

The seafloor on the continental shelf in the Gulf of Mexico consists primarily of muddy to sandy sediments populated by deposit feeding infauna as well as shrimps, crabs, and finfishes (Section 3.1.2.7.6). The slope and deep sea consist of vast areas of primarily fine sediments, and support benthic communities with lower densities and biomass but higher diversity than the continental shelf (Rowe, 2000). Due to the large geographic areas of the continental shelf, slope, and deep-sea habitats, and the widespread nature of the soft-bottom communities, activities occurring under the proposed action would disturb only a relatively small proportion of the resource and would have minimal impact on its diversity or productivity.

Routine Operations

Impact producing factors that could affect benthic communities of the continental shelf and slope include placement and removal of structures, and operational discharges and wastes.

Placement of MODU's and platforms disturbs the seafloor and may crush or bury soft-bottom benthic organisms. Jack-up rigs disturb bottom sediments and benthic organisms beneath and near the "feet" of the rig. Slightly larger areas of seafloor may be disturbed by anchors and chains from semisubmersibles or other floating drilling platforms. The area of impact for jack-up rigs could include up to the surface areal extent of the drilling rig itself (if no anchors were used), or the area falling within the radial pattern of positioning anchors, if used. Floating drilling structures would use either an anchoring system or dynamic positioning to maintain station. Anchored structures would typically use eight anchors, with the amount of bottom impacted increasing with water depth due to the larger anchors and longer anchor chain required. The installation of production platforms would also impact the area of the seafloor beneath the platforms where the legs entered the seabed and where subsea equipment such as reentry collars and blowout preventers were installed. The actual area of seafloor impacted by anchoring operations would depend upon water depth, currents, size of the vessels and anchors, and length of anchor chain. Anchoring would most likely kill any benthic organisms hit by the anchor or chain during anchor deployment and recovery.

The estimated number of platforms that would be placed under the proposed action would range from 183 to 320, and they would disturb from 281 to 475 ha of seafloor. If all estimated bottom disturbing activities were to occur under the proposed action, the maximum area of seafloor in the entire Gulf of Mexico (including the continental shelf, slope, and deep-sea habitats) that would be directly affected would be less than 6,325 ha out of an approximate area of more than 80,000,000 ha. Soft-bottom benthic communities would recover over a period of months without mitigation. Impacts would be minor.

Flowline or pipeline placement or removal would also affect benthic organisms along the corridor. In water depths less than 61 m where pipelines must be buried, benthic organisms within the trenched corridor would be killed or injured, and organisms to either side of the pipeline would be temporarily buried by sediments. Estimates of total bottom area disturbed by pipelines as a result of the proposed action range from 2,000 to 5,850 ha. The communities would recover over a period of months without mitigation. Impacts would be minor.

Structure removal activities could result in increased turbidity, resuspended bottom sediments, and explosive shock wave impacts. Deposition of resuspended sediments could bury, smother, or kill some benthic organisms near the site. Benthic organisms are relatively resistant to the direct effects of underwater explosive blasts. O'Keeffe and Young (1984) found that oysters exposed to 300-pound (lb) charges in open water showed only 5-percent mortalities at distances of 8 m. Crabs exposed to 30-lb charges at 8 m exhibited 90-percent mortalities, while those exposed to the same charge at 46 m showed almost no mortalities. The impacts from the explosive removals of the platforms would also be attenuated by the movement of the shock wave through the seabed, as the charges are set at 5 m below the seafloor surface. It is assumed that a total of 140-250 platforms would be removed; assuming an average 2 ha occupied by each platform, the total area to be disturbed during platform removal can be expected to range from 280 to 500 ha. These estimates of bottom area disturbed via platform removal are small compared to total seafloor area in the entire Gulf of Mexico Region. Soft-bottom benthic communities would recover over a period of months without mitigation. Impacts would be minor.

The discharge of drilling muds and cuttings would be highly localized (generally within a few hundred meters of a drill site) and could result in the deposition of mud and cuttings to a thickness of up to 1 m directly below and around a platform. This could cause smothering of organisms, disruption of feeding patterns, and changes in sediment grain size in the immediate area. This impact would be short in duration, with repopulation of the area occurring by larval recruitment, although a different community may initially recruit to the area because of the change in sediment granulometry. The benthic community would eventually recover over a period of months to years without mitigation. Impacts would be minor.

Produced water discharges could cause an elevation of contaminants in sediments at water depths of less than 400 m, with localized impacts to benthic organisms possible within 100 m of the discharge point at some platforms on the inner continental shelf. After discharges ceased, the benthic community would eventually recover over a period of months to years without mitigation. Impacts would be minor.

Accidents

Pipeline spills are the only accidents considered that are likely to affect seafloor habitats and benthic communities. Relevant spills in the proposed action scenario (Table 4-1e) are four pipeline spills (4,600 bbl), one in deep water in the Western Gulf of Mexico Planning Area, one in shallow water and one in deep water in the Central Gulf of Mexico Planning Area, and one in shallow water in the Eastern Gulf of Mexico Planning Area. Other large spills are assumed to occur at the surface with little chance of affecting benthic communities. Small spills (Table 4-1e) also are assumed to occur at the surface and have no benthic effects.

Oil spills from pipeline ruptures could affect benthic communities near the spill site. Benthic organisms could be smothered by oil or killed or stressed due to toxicity of the hydrocarbons. Hydrocarbons should be diluted to background levels within a few hundred meters to a few kilometers of the spill site. The seafloor habitat would recover without mitigation due to natural breakdown of the oil, sediment movement by currents, and reworking by benthic fauna. The benthic community would probably recover more quickly from a shallow-water pipeline spill than from a deepwater pipeline spill, due to the greater potential for wave-induced resuspension of sediments in shallow water. Due to the ubiquitous nature of the soft-bottom communities on the continental shelf and slope, impacts from oil spills would be localized in nature and the communities would soon recover through larval recruitment from adjacent areas. Impacts would be minor.

Conclusion: Impacts on soft bottom benthic communities due to routine operations and accidents under the proposed action would be **minor**.

4.3.2.10. Areas of Special Concern

4.3.2.10.1 Essential Fish Habitat

An explanation of essential fish habitat (EFH) is in Appendix E**.** The EFH within the Gulf of Mexico was described in Section 3.1.2.8.1. Most of the coastal and marine waters of the Gulf of Mexico are considered EFH for life stages of one or more managed species. Coastal and inshore waters are important juvenile habitat for several managed fish species. Habitat relationships among species and life stages can be complex and can present a considerable challenge to fisheries managers (Lindeman et al., 2000). Any activity that degrades coastal and marine environments would impact EFH (USDOI, MMS, 1999). Similarly, the benthic environment is an important EFH component for one or more managed species. The MMS has consulted at a programmatic level with NMFS on EFH for Central and Western Gulf of Mexico Planning sales and has developed mitigation measures to reduce or eliminate impacts.

Routine Operations

Impacts of routine activities on EFH include disturbance of bottom sediments during placement of drilling units and production platforms. Sediment disturbance will result in increased turbidity, which will lower the water quality of EFH in a small area for a limited amount of time, causing fish to leave the area. However the sediments reintroduced into the water column will eventually settle out and not have a lasting effect on the water quality. Placement of jacket legs will smother some benthic prey of managed species. Most of the displaced habitat will occur in the Central Gulf of Mexico Planning Area. Installation of pipelines also disturbs, resuspends and displaces bottom sediments. Bottom area EFH that may be disturbed by new pipeline installation ranges from 700 to 2,000 ha in the Western Gulf of Mexico Planning Area, 1,100-3,300 ha in the Central Gulf of Mexico Planning Area and 200-550 ha in the Eastern Gulf of Mexico Planning Area.

Drilling cuttings discharges will occur in all three planning areas (Table 4.1a). These discharges will alter the grain size distribution and chemical characteristics of sediments around drill sites, which will change benthic habitat for EFH prey species as well as spawning sites for red snapper which prefers fine-sand bottoms away from reefs at depths of 18 to 37 m.

Effects of produced water, PAH's and NORM on waters and substrate as a part of EFH is discussed in Section 4.3.2.1.

Hard-bottom EFH should not be affected by the deposition of drilling muds and cuttings because of lease stipulations preventing discharges in these areas. Habitat areas of particular concern (HAPC's) include offshore areas with substrates of high habitat value and diversity or vertical relief such as coral, various types of live rock, and other hard bottom areas.

Once platforms are established, sessile fouling organisms will colonize the hard substrate which will attract prey and managed fish species. Over time, this may change the spawning, breeding, and feeding patterns of these fish.

During decommissioning and structure removal, explosives may be used to sever conductors and pilings because of their combined thickness and sturdiness. Possible injury to biota from explosive use extends outward 900 m from the detonation source and upward to the surface. Based on MMS data, it is assumed that approximately 70 percent of removals of conventional, fixed platforms in the Gulf of Mexico waters less than 400 m deep will be performed with explosives (USDOI, MMS, 1996a). The majority of platform removals by explosives (between 100 and 190 platforms) are located in the Central Gulf of Mexico Planning Area. Some of the fouling community that are prey for managed fish species will be destroyed.

Accidents

The EFH for many migratory fish species include surface water habitat for egg and larval stages of development. All oil spills will have an impact on EFH in surface water for planktonic eggs and larvae. Trapped eggs and larvae will be unable to move from the area and will be killed. Wave and wind action, weathering, and biogenic degradation would dissipate oil in the surface water, and EFH will be reestablished.

The shallow platform spill (1,500 bbl) in the Western Gulf of Mexico Planning Area, the shallow water pipeline spill (4,600 bbl) and platform spill (1,500 bbl) in the Central Gulf of Mexico Planning Area, and the shallow water pipeline spill (4,600 bbl) in the Eastern Gulf of Mexico Planning Area all have the potential to impact the coastal environment. Coastal HAPC's include nearshore areas of intertidal and estuarine habitats with emergent and submerged vegetation, sand and mud flats, and shell and oyster reefs. These areas provide food and rearing substrate for federally managed juvenile fish and shellfish. The EFH for many managed species and their prey includes coastal, estuarine or wetlands as habitat for at least some portion of their life history.

Oil reaching the surface from the deepwater pipeline spill (4,600 bbl) in the Western Gulf of Mexico Planning Area and the deepwater tanker spill (5,300 bbl) in the Central Gulf of Mexico Planning Area could affect EFH for the eggs and larvae of federally managed pelagic fish species, neuston prey species, and *Sargassum* and its associated fauna. Pelagic larvae contacting the oil would be smothered, and *Sargassum* would be fouled.

Blowouts can occur during exploration drilling, development drilling, production, or work over operations. Historically, 23 percent of all blowouts result in oil spills. In subsurface blowouts, sediment of all available sizes resuspend, and the bottom disturbance is within a 300-m radius (USDOI, MMS, 1996a). Refer to Section 4.3.2.6.2. for effects on increased turbidity on fish and associated benthic communities.

Conclusion: Potential impacts on EFH due to routine operations under the proposed action would be **minor**. Accidents such as petroleum spills and subsurface blowouts could also have effects on EFH. Most potential impacts on EFH due to accidents under the proposed action would be **minor**. However, should a spill reach coastal wetlands, more persistent, **moderate** impacts requiring remediation could occur.

4.3.2.10.2. National Marine Sanctuaries

Routine Operations

The Flower Garden Banks National Marine Sanctuary is located offshore of Texas and Louisiana in the Western Gulf of Mexico Planning Area (Figure 3-12). The sanctuary has been described in Section 3.1.2.8.2. Factors potentially affecting the Flower Garden Banks National Marine Sanctuary include the structure placement and operational discharges and wastes. Due to protective stipulations as described below, impacts would be avoided.

Because the Flower Garden Banks National Marine Sanctuary includes the most significant topographic features in the northwestern Gulf of Mexico, its biological resources have been protected by adding requirements to the Topographic Features Stipulation. The stipulation includes (1) establishment of a "No Activity Zone" based upon the 100-m isobath instead of the 85-m isobath, and (2) implementation of a 4-mile zone rather than a 1-mile zone in which shunting of drilling muds and cuttings to within 10 m of the bottom is required. Stetson Bank, which was added to the sanctuary in 1996, does not have a 4-mile shunting zone, but otherwise has the same protections as the Flower Garden Banks.

Coral communities are sensitive to physical damage from anchoring and placement of structures on the bottom. However, the Topographic Features Stipulation precludes these activities within the No Activity Zone surrounding the banks. Assuming that operators comply with the stipulation, all impacts would be avoided. Impacts from anchoring and placement of structures under the proposed action are expected to be negligible.

Coral communities are also sensitive to turbidity and sedimentation. Drilling mud and cuttings discharges could cause increased turbidity in the water column and deposition of sediments on the corals and other reef biota. Produced water discharges could cause an elevation of contaminants in sediments, with localized impacts to benthic organisms possible within 100 m of the discharge point. However, the Topographic Features Stipulation precludes discharges within the No Activity Zones of each bank and requires shunting of drilling mud and cuttings discharges to within 10 m of the seafloor within a radius of 7.4 km (or 1.9 km for Stetson Bank). This effectively avoids discharge impacts to bank biota, and impacts from these activities would be negligible.

The Florida Keys National Marine Sanctuary is located offshore of southern Florida in the Eastern Gulf of Mexico Planning Area (Figure 3-12). The sanctuary has been described in Section 3.1.2.8.2 and includes various sensitive habitats, including coral reefs, seagrass beds, and mangrove shorelines. Zones have been established with special restrictions to protect sensitive habitats. In addition, the following activities are prohibited: operation of a tank vessel or a vessel greater than 50 m in length, except public vessels; and leasing, exploration, development, or production of minerals or hydrocarbons.

Routine operations from oil and gas exploration and production would have no impact on the biota of the Florida Keys National Marine Sanctuary. The proposed action does not include any activities within 500 km of the sanctuary.

Accidents

The only relevant large oil spill assumed for the proposed action is a pipeline spill in deep water in the Western Gulf of Mexico Planning Area (Table 4-1e). Additional small spills are also assumed in the Western Planning Area (Table 4-1e). It is possible that a large pipeline spill from outside the No Activity Zones could reach the vicinity of the Flower Garden Banks. However, because of the depth of the banks, the biota would probably not be affected by the subsurface oil. With the crests of the two banks being at least 15 m below the surface, concentrations of any oil driven to at least this depth would be far below that capable of causing an impact. Subsurface oil spills would have to come into contact with a bank feature almost immediately to have any detrimental impact, due to the rapid dilution of the spill. Furthermore, water currents moving around the banks would carry the spill components around the banks rather than directly over the features, lessening the severity of the impact. Any impacts associated with a spill reaching sensitive biota would most likely be sublethal, with recovery occurring within an estimated 2 years. Most impacts of spills would be avoided due to the existing mitigation measures (No Activity Zones), and if oil were to reach the banks, resources would most likely recover without mitigation. Therefore, impacts from a large pipeline oil spill would be minor.

Small spills are assumed to occur at the surface and would be unlikely to affect bank biota. Oil from surface spills can penetrate the water column to documented depths of 20 m. At these depths, however, oil concentrations are several orders of magnitude lower than those demonstrated to have an effect on marine organisms. Due to the water depths of the Flower Gardens Banks, it is unlikely that any significant amounts of oil from surface spills would reach sensitive communities. Small spill impacts are expected to be negligible.

The proposed action does not include any leasing activities near the Florida Keys National Marine Sanctuary, with the nearest potential lease areas located more than 500 km to the northwest of the sanctuary. The distance would prevent spills from either platforms or pipelines in the Western, Central, or Eastern Gulf of Mexico Planning Areas (or a tanker spill in the Central Planning Area) from reaching the sensitive reef communities of the sanctuary; therefore, impacts from these sources would be negligible.

Conclusion: Potential impacts on the Flower Garden Banks National Marine Sanctuary and the Florida Keys National Marine Sanctuary due to routine operations under the proposed action would be **negligible**. Potential impacts from accidents on the Flower Garden Banks National Marine Sanctuary under the proposed action would be **minor**. Potential impacts on the Florida Keys National Marine Sanctuary due to accidents under the proposed action would be **negligible**.

4.3.2.10.3. National Parks, Reserves, and Refuges

Routine Operations

Routine activities potentially affecting parks, reserves, and refuges include placement of structures, pipeline landfalls, operational discharges and wastes, and vessel and aircraft traffic. It is assumed that pipeline landfalls, shore bases, and waste facilities would not be located in national parks, national wildlife refuges, or national estuarine research reserves (Figure 3-16); therefore, there would be no impacts from these activities on these resources in any Gulf of Mexico Planning Area.

It is possible that shore bases and waste facilities may be located in one or more estuaries in the Western or Central Gulf of Mexico Planning Areas that are included in the national estuary program. These could include Corpus Christi Bay, Galveston Bay, Barataria-Terrebonne Estuarine Complex, and Mobile Bay. It is assumed that the new shore bases and waste facilities would be constructed in existing developed or upland areas and that they would not be sited in coastal habitats such as barrier beaches or wetlands. Therefore, impacts on estuarine habitats and biota characteristic of the National estuary program sites would not be measurable.

Trash and debris from various sources, including OCS operations, frequently wash up on beaches, including areas of special concern such as the Padre Island National Seashore. The discharge or disposal of solid debris from both OCS structures and vessels is prohibited by the MMS (30 CFR 250.40) and the U.S. Coast Guard (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]). Assuming that operators comply with regulations, most potential impacts would be avoided, although some accidental loss of materials is inevitable. It is difficult to estimate the amount of such materials that would be attributable to activities from the proposed action. Locally, accumulations of trash on beaches require remediation (cleanup).

Over time with a large number of vessel trips, vessel wakes can erode shorelines along inlets, channels, and harbors. It is assumed there would be no routine support vessel traffic in the harbors, channels, or waterways of the Eastern Gulf of Mexico Planning Area and therefore no impacts on the national parks, national wildlife refuges, or national estuarine research reserves located in Florida.

Of the national parks, only the Padre Island National Seashore located adjacent to regions in which oil and gas activities could occur. Other potentially affected areas are the national wildlife refuges inshore of the Western and Central Planning Areas (Table 3-11) and two national estuarine research reserve sites in the Central Planning Area (Grand Bay and Weeks Bay). Existing mitigation measures limit vessel speeds in inland waterways and aircraft altitudes over areas of special concern. With these measures in place, most impacts to these areas of special concern due to vessel and aircraft traffic would be avoided.

Accidents

The potential exists for impacts on national parks, national wildlife refuges, national estuarine research reserves, or national estuary program sites if a large oil spill were to reach sensitive coastal habitats within these areas. Impacts could result from both oiling of the shoreline and mechanical damage during the cleanup process.

The scenario developed for the analysis of the proposed action assumes that as many as four shallow-water spills (Table 4-1e) could affect these areas of special concern: a platform spill (1,500 bbl) in the Western Planning Area; a pipeline spill (4,600 bbl) and a platform spill (1,500 bbl) in the Central Planning Area; and a pipeline spill (4,600 bbl) in the Eastern Planning Area (assumed to occur in shallow water). It is assumed that spills taking place in deeper water are not likely to affect coastal areas. It is also assumed that the deepwater spills would either be transported away from coastal habitats, or that natural weathering processes would prevent most of the oil from reaching the coast.

Among the national parks, only the Padre Island National Seashore and Gulf Islands National Seashore could be potentially affected (Figure 3-12). Potentially affected national wildlife refuges are any of those listed in Table 3-11 that are located in Texas, Louisiana, Mississippi, or Alabama Potentially affected national estuarine research reserve sites are Grand Bay, Weeks Bay, and Rookery Bay. Potentially affected national estuary program sites are Corpus Christi Bay, Galveston Bay, Barataria-Terrebonne Estuarine Complex, and Mobile Bay.

Impacts on estuarine wetlands within areas of special concern would depend upon the size and specific location of the oil spill and the effectiveness of cleanup procedures. Impacts could include death of wetland vegetation and associated wildlife; oil saturation and trapping by vegetation and sediments (thus becoming a chronic source of pollution); and mechanical destruction of the wetland area during cleanup. Areas where coastal wetlands front directly on the open Gulf, such as those seen in the Central Gulf of Mexico Planning Area, are particularly vulnerable to spilled oil under the accident scenarios assumed above. Most oil contacting wetlands is not expected to have long-lasting adverse effects. Spills that damage wetland vegetation protecting canal and waterway banks could accelerate erosion of those banks (Alexander and Webb, 1987). Some areas may recover completely if proper remedial action were taken. Others may not recover completely, but the overall viability of the resource would not be threatened by a spill of 4,600 bbl or less. Although areas of special concern might also be affected by small oil spills (Table 4-1e), it is assumed they would recover without mitigation.

Conclusion: Overall impacts on national parks, national wildlife refuges, national estuarine research reserves, and national estuary program sites due to routine operations would be **negligible** to **minor**. Overall impacts from oil spills that contacted national parks, national wildlife refuges, national estuarine research reserves, or national estuary program sites could be **minor** to **moderate**.

4.3.2.11. Population, Employment, and Regional Income

4.3.2.11.1. Routine Operations

The MMS estimates regional economic impacts in a two-step process. The models for the Gulf of Mexico and Alaska were developed separately but are consistent in their approach. The models combine three categories of OCS-related job impacts: direct employment, indirect employment, and induced employment. Direct employment is that actually engaged in OCS activities. Indirect employment supports the OCS activity with ancillary goods and services produced onshore. Induced employment grows from the expenditures of direct and indirect employees and their families. Projections of direct employment are based on the exploration and development scenario for the proposed action (see Section 4.3.1 and Table 4-1a). High- and low-range estimates of activity drawn from this scenario form the basis for a range of estimates of employment and regional income effects.

The model first estimates the expenditures required to support the activity levels in a specific exploration and development scenario, and allocates these expenditures to the various industrial sectors in the geographic units of interest. For example, the expenditures resulting from activities in the Western Gulf of Mexico Planning Area would be allocated to coastal Texas, the "Rest of the Gulf of Mexico," and the "Rest of the United States." The activities are meant to be comprehensive, including exploration drilling, platform fabrication and installation, pipeline construction and installation, and various other construction and maintenance functions required to support the phases of development. The activities are specific to the location of the activity, ranging from 11 kinds of activities in the Gulf of Mexico to 24 in offshore Arctic Alaska.

The second step in the process is estimating how the initial dollars spent in a geographic area reverberate through the economy. The MMS model employs multipliers taken from the widely used IMPLAN model. For each economic sector, these multipliers are used to estimate the employment and personal income generated by three levels of economic activity. These three levels are the spending of the companies involved in the primary activities ("direct" effects), that of the supporting vendors and contractors ("indirect" effects), and that of employee households ("induced" effects). The results are summations of the sector-by-sector calculations. Table 4-9 shows totals of the direct, indirect, and induced employment and regional income for each of the States, the rest of the Gulf of Mexico, and the rest of the United States.

The projections for the coastal areas in Table 4-9 show a range of 58,000 to 120,000 jobs in an average year attributable to the proposed program. This amounts to between 0.3 percent and 0.7 percent of the overall regional employment. In Texas the range is 24,000 to 52,000 jobs. In Louisiana it is 31,000 to 61,000. In the other Gulf Coast States employment impacts will be much less.

The additional jobs will create small but noticeable increases in the population of these regions. Using an historically observed ratio of 1.9 persons per new job, we would expect population increases of 110,000 to 230,000 over the life of the proposed action.

4.3.2.11.2. Accidents

Variables such as total volume of oil reaching land, land area affected, and sensitivity of local environmental conditions to spilled oil can have a considerable influence on oil-spill employment impacts. Primary resource extraction (excluding oil and mining activities) and tourism are the industry categories most sensitive to landfall of spilled oil. Primary resource extraction (primarily fishing and supportive agricultural services) is directly affected by environmental conditions. Similarly, the perceived aesthetics and recreational opportunities of the coastal environment affect tourism. Oil spills reaching land can have both short- and long-term effects on coastal recreation activities.

Employment in the coastal labor market areas throughout the Gulf of Mexico is projected to increase to 2.2 million jobs in impact sensitive industries by 2020 (Table 4-10). This is some 380,000 jobs higher than the 2000 level. The jobs potentially affected by oil spills are projected to contribute some 17.9 percent of the overall employment growth in the Gulf coastal area. Impact sensitive industries are most important to overall job growth in Louisiana, Mississippi, and Alabama, adding some 21 percent of net growth in this region. It is also in this region that the majority of spills associated with the proposed action activities are assumed to occur (Table 4-1e).

The primary impacts of oil spills would most likely fall on such activities as beach recreation, diving, commercial fishing, recreational fishing, and sightseeing. Past studies (Sorensen, 1990) have shown that there could be a one-time seasonal decline in tourist visits of 5 to 15 percent associated with a major oil spill. Since tourist movement to other coastal areas in the region often offsets a reduction in the number of visits to one area, the associated loss of business is very localized. Tourism and primary resource production activities largely shift to new coastal areas in the region. However, those labor markets with more than 20 percent of projected future job growth in impact sensitive industries have the greatest economic risk associated with oil spills.

Conclusion: Based on proposed action scenario assumptions, the employment and regional income impact would likely be greatest in Texas and Louisiana. Even for the areas most affected, however, added employment demands would not likely tax the local labor market. Impacts are expected to be **negligible** to **minor**. Oil spills included in the proposed action scenario may have some temporary impacts upon specific local areas. However, at the regional level, these impacts are considered to be **negligible**.

4.3.2.12. Land Use and Existing Infrastructure

Routine Operations

The proposed action continues, for the most part, a steady pace of offshore leasing (and re-leasing) that has persisted in the Gulf of Mexico for two decades or more. This well-established trend is already reflected in most land use patterns in the Western and Central Gulf of Mexico Planning Areas. Table 4-1a indicates up to four new shore bases in the western and central Gulf areas (3 in the western, and 1 in the central). Minor to negligible impacts to land usage is expected by the continuation of leasing and subsequent exploration and development activities in the Western and Central Gulf of Mexico Planning Areas, respectively. With more amenity-driven coastal areas, land use in the Eastern Gulf of Mexico Planning Area is generally more vulnerable to impact associated with lease sales and subsequent offshore activity. However, the leasing activity under the proposed action (and the exploration and development activity assumed to follow) is minimal, as is the associated oil and gas onshore activity. Table 4-1a indicates no new shore bases, processing facilities, or waste facilities required in the eastern Gulf area, resulting in negligible impact on land-use patterns in this portion of the Gulf of Mexico.

It is well established that externalities such as volatile commodity prices can impact areas where oil and gas industry activities are concentrated. This volatility is reflected in significant (i.e., > 1% per year) in- and out-migration flows. Some of the labor market areas (LMA's) in the Western and Eastern Gulf of Mexico Planning Areas exhibit as much as a 2.5-percent net migration change in a single year. If in-migration occurs at this projected level and magnitude, public infrastructure (e.g., roads, highways, schools, housing) can be strained beyond reasonable limits. These high rates of in-migration are invariably followed by compensating rates of out-migration, which tend to return areas to an equilibrium. Under the proposed scenario, some episodic stress on public infrastructure can be expected as factors external to the coastal LMA's affect local oil and gas activities. The few areas equipped to support deepwater development activities may experience more sustained stress on infrastructure. Deepwater development activity to date has not fluctuated with the same intensity as shallow-water development. A case in point is the Port Fourchon area of coastal Louisiana, where a State highway has been steadily eroded by large truck traffic. Without mediating efforts at infrastructure restoration, the impact in these isolated cases could be moderate, and in the case of Port Fourchon even major. Nonetheless, for the great majority of coastal LMA's from Texas to Florida, the impact on infrastructure associated with adoption of the proposed action will be negligible.

Accidents

Potential oil spills assumed to occur under the proposed action will prompt an appropriate level of spill response, primarily from existing response facilities along the Gulf Coast. Supplies may also be stockpiled at existing or planned shore bases. Four new shore bases are projected for the western and central Gulf (i.e., 3 for the western Gulf; 1 for the central Gulf). No new shore bases are projected for the eastern Gulf (Table 4-1a). Given the current level of existing infrastructure in the Gulf of

Mexico region and the region's history with oil and gas operations (including spill response), impacts to land use and existing infrastructure from oil spills under the proposed action would be minor.

Conclusion: Based on the proposed scenario, impacts from routine operations upon land use and infrastructure onshore of each of the three planning areas ranges from **negligible** to **minor**. However, isolated areas could realize **moderate** impacts in the absence of mediating efforts at infrastructure restoration; in the case of Port Fourchon, such impact levels could be **major**. If oil spills were to occur and contact the coast, impacts to land use and existing infrastructure would be **minor**.

4.3.2.13. Fisheries

4.3.2.13.1. Commercial Fisheries

Routine Operations

Impact factors potentially affecting commercial fisheries in the Gulf of Mexico include structure placement, presence, and removal, and vessel traffic. The most important impact to shelf and deepwater fisheries from oil and gas structures and their attendant activities is space use: the preclusion of fishers from viable fishing grounds over time.

Exploration activities such as placement of MODU's and deposition of cuttings will cause turbidity and drive fishes away from the area. Noise from drilling activities and pipeline installation may also cause fishes to move from the area. Because of potential conflicts between exploration activities and fishing gear, bottom trawlers, longliners, and purse netters would be precluded from areas surrounding exploration activities. However, these periods of exclusion would be temporary.

Once platforms are installed and production activities begin, fishes would return to the disturbed area. These offshore structures will act as FAD's for both pelagic and reef-associated species; these structures would also be attractive to handline fishers. However, to avoid potential conflicts, a "no fishing" area surrounding the platforms during production is established. The seafloor area precluded by platforms would range from 75 to 115 ha in the Western Gulf of Mexico Planning Area, 200 to 350 ha in the Central Gulf of Mexico Planning Area, and 6 to 10 ha in the Eastern Gulf of Mexico Planning Area. Seafloor area precluded by pipelines ranges from 700 to 2,000 ha in the Western Gulf of Mexico Planning Area, 1,100 to 3,300 ha in the Central Gulf of Mexico Planning Area, and 200 to 550 ha in the Eastern Gulf of Mexico Planning Area. These areas are small relative to the total area available to fishers in the northern Gulf of Mexico.

Total area precluded will vary depending upon the nature of a particular structure or the phase of operation; fishing method or gear; and target species group. Space-use impacts would be higher for drifting gears such as purse nets, bottom longlines, and pelagic longlines than for trawls and handlines (Centaur Associates, Inc., 1981; USDOI, MMS, 2000). Nevertheless, areas of preclusion are small relative to the entire fishing area utilized by surface longliners or purse seiners.

The area precluded during platform decommissioning would depend on several factors, including when each decommissioning step is completed relative to the remaining steps. Decommissioning and removal of facilities is optimal from a commercial fishing perspective. On-site abandonment of several components will ensure that several potential seafloor obstacles remain such as flowlines, anchors, and mooring lines, which would present obstacles to trawling. Federal Regulations (30 CFR 250.702(I)) require that all wellheads, casings, piling, and other obstructions shall be removed to a depth of at least 15 feet below the mud line or to a depth approved by the MMS District Supervisor.

Areas left untrawlable will represent only a fraction of the area excluded by oil and gas operations. Following decommissioning and removal, surface waters will no longer be precluded. Therefore, surface longlining will not be affected.

Accidents

Commercial fisheries could be affected by any of the large oil spills assumed in the proposed action scenario (Table 4-1e). These include one shallow platform spill (1,500 bbl) and one deep pipeline spill (4,600 bbl) in the Western Gulf of Mexico Planning Area. One shallow platform spill (1,500 bbl), 1 shallow and one deep pipeline spill (4,600 bbl each), and one deep tanker spill (5,300 bbl) are assumed to occur in the Central Gulf of Mexico Planning Area. One shallow pipeline (4,600 bbl) is assumed in the Eastern Gulf of Mexico Planning Area. A number of small spills are also assumed in each planning area (Table 4-1e).

Commercial fisheries could be affected by oil spills in several ways. The possibility of oil soaked fishing gear and potentially contaminated fish may reduce commercial fishing efforts, resulting in economic loss. Individuals of target fish species could be affected directly by exposure to spilled oil. Hydrocarbons from spilled oil can affect adult fishes by direct contact with gills or in the gut after swallowing spilled oil. Toxic fractions of PAH's in spilled oil can cause death or illness in adult fishes, but exposure to these fractions must be continuous. Adult and juvenile fishes should actively avoid a large spill; however, the planktonic eggs, larvae neustonic communities such as sargassum and their associated invertebrate and fish species would be unable to avoid spilled oil. Eggs and larvae of fishes will die if exposed to certain toxic fractions of spilled oil. Most of the fishes inhabiting shelf or oceanic waters of the GOM have planktonic eggs and larvae (Ditty, 1986; Ditty et al., 1988, Richards and Potthoff, 1980; Richards et al., 1993). Some groups such as damselfishes and triggerfishes deposit demersal eggs, the newly hatched larvae take up residence in the water column. Affects would be potentially greater in areas where local scale currents retained planktonic larval assemblages (and the floating oil slick) within the same water mass.

Spills could also indirectly affect commercial fisheries by degrading habitats that are critical for the survival of target species. These impacts would only be serious to commercial fisheries if they lead to large declines in target species populations. This would require large areas of coastal habitat including wetlands and seagrass beds to be negatively impacted. Coastal habitats could be affected by oil spills in shallow water, but they are not likely to be affected by spills in deep water.

Oil spills reaching coastal and wetland areas could cause death of wetland vegetation, seagrass beds and associated fauna; oil saturation and trapping by vegetation and sediments (thus becoming a chronic source of pollution); and mechanical destruction of the wetland area during cleanup. Areas where coastal wetlands front directly to the open Gulf, such as in the Eastern and Western Planning Areas, are particularly vulnerable to nearshore oil spills. Some areas may recover completely, but overall the viability of the wetland resource would not be threatened. Others may not recover completely. Submerged seagrass beds could also be damaged if an oil spill were to reach coastal waters. Some commercially targeted shrimps and other invertebrates, reef fish, and highly migratory species use wetlands and coastal habitat as a nursery ground for their eggs, larvae and juveniles/subadults. Based on the level of impacts to coastal habitats including wetlands and submerged seagrass beds under the proposed action, such population declines are not likely to occur.

Adult highly migratory fish species including some of the pelagics (tunas, sharks and billfish) would move away from surface oil spills in deep water. Pelagic larvae and neuston would not be able to move away from the spilled oil on the surface and would most likely be killed or injured.

Other impacts involve interference with fishing operations, preclusion of traditional fishing areas, tainting of catches, and fouling of gear (e.g., Bolger et al., 1996; Hom et al., 1996). The ultimate effect to individual fishers is loss of income and, at worst, loss of livelihood in a particular region.

Conclusion: Potential impacts on commercial fisheries due to routine operations and accidents would be **minor** to **moderate**. Based on the sizes of oil spills assumed for the proposed action, only localized and short-term disruption of commercial fishing activity might result (**minor** impact).

4.3.2.13.2. Recreational Fisheries

Routine Operations

The most significant impact of routine operations on recreational fisheries is space use. Placement of MODU's disturbs the seafloor, causes turbidity, and may temporarily drive fishes away from the general area. These activities would primarily affect soft bottom species such as red drum, sand sea trout, and spotted sea trout sought by anglers in private or charter/party vessels. Fishes would, however, eventually return to the disturbed area.

The presence of offshore platforms *per se* is an important factor. About 58.5 percent of all recreational fishing trips made in the eastern and central Gulf (Florida, Alabama, Mississippi, and Louisiana) during 1998 were from private and charter/party vessels (USDOI, MMS, 2001). About 63 percent of these trips were made in inland waters, with the remainder (37%) of the trips made in inshore or offshore waters of the Gulf of Mexico. The presence of structures would have a FAD effect on pelagic (e.g., king mackerels, tunas, cobia) and reef-associated species (e.g., red snapper, gray triggerfish, amberjack) that would also be attractive to most recreational fishers.

Accidents

Recreational fisheries could be affected by any of the oil spills in the proposed action (Table 4-1e). Accidental oil spills can affect recreational fisheries directly, by contaminating target species through ingestion of spilled oil, and indirectly, by degrading habitats that are critical for the survival of target species. Impacts affecting recreational species or the ability to fish for these species can have broad effects on local economies. Motels, restaurants, bait and tackle shops, charter boats, guides, and other supporting industries can feel the economic losses caused by declining fishing activity. A major oil spill that degrades the esthetic value of a particular shoreline could deter fishers from using an area even if the impact to fish stocks were negligible. Based on the number and size of spills assumed for the proposed action, persistent degradation of shorelines and waters are not likely to occur.

Conclusion: Potential impacts on recreational fisheries due to routine operations and accidents would be **minor** to **moderate**. Based on the sizes of oil spills assumed for the proposed action, only localized and short term disruption of recreational fishing activity might result (**minor** impact).

4.3.2.14. Tourism and Recreation

Routine Operations

The coastal zone and waters of the Gulf of Mexico offer residents and visitors diverse opportunities for recreational and tourism activities. In addition to the attributes of individual coastal communities, the region's coastal beaches, barrier islands, estuaries, bays and sounds, river deltas, and tidal marshes, as well as nearshore and offshore marine waters, offer a variety of different opportunities for beach and waterways use.

Projections of tourism and travel employment includes public transportation, auto transportation, lodging, food service, entertainment and recreation, general retail trade, travel, and travel planning (Table 4-10. While these industries comprise an important part of the employment base for all commuting zones in the Gulf in 16 of the 23 commuting zones, travel and tourism is projected to grow by at least 14 percent in the next 20 years. In these areas, continued growth in travel and tourism is central to future economic health. While these activities may be found throughout these labor market areas, primary impacts of OCS oil and gas operations would only be likely to impact such activities as beach recreation, diving, recreational fishing, and sightseeing. These activities comprise a small but important part of travel and tourism.

Routine OCS activity may adversely impact these activities through increased trash and debris fouling beaches, noise pollution associated with increased helicopter traffic, and boat traffic. Esthetic degradation of beach areas, estuaries, and ocean views may be associated with pipeline landfall and offshore platforms. Trash, debris, and tar balls from OCS operations can wash ashore on Gulf of Mexico recreational beaches and reduce their attractiveness as recreational resources. Some trash items, such as glass, steel, and drums with chemical products or residues, can also be a health threat to users. Further, temporary closings of beaches and sightseeing areas associated with pipeline construction may affect tourism and recreational opportunities in specific areas. However, various studies have also demonstrated positive impacts associated with offshore oil platforms, such as benefits to recreational fishing and diving around the reef-like habitats provided by oil and gas platforms (Ditton and Graefe, 1978; Roberts and Thompson, 1983; Witzig, 1986).

Continued OCS leasing in the Gulf of Mexico over the next 40 years under the proposed action is assumed to result in an additional installation of new offshore platforms off Louisiana, Texas, Alabama, and Florida. Drilling rigs and production platforms placed in the first two tiers of Federal lease blocks off major recreation and tourist destination areas like Padre Island National Seashore and Galveston Island in Texas may be barely visible from shore under very clear weather conditions, but are not expected to affect use and appreciation of coastal beaches and parks. Most of the platforms and associated drilling operations estimated for installation in waters off Texas, Louisiana, Mississippi, Alabama will occur far from shore and have no direct effects on coastal park and recreation areas. A few platforms and drilling rigs may be situated in currently unleased nearshore tracts within 3-10 miles from shore where they will be visible and recognizable as oil and gas operations. No platforms will be located closer than 100 miles from the Florida coastline. Some tourists and recreation users on coastal beaches along Louisiana, Mississippi, and Alabama will be affected by the sight or sound (helicopter and boat traffic) of OCS oil and gas operations but few, if any, are expected to forego their visits because of these routine intermittent operations. Pipeline landfalls could cause temporary removal of shoreline recreational land from public use for a period of 2-3 weeks. Pipeline landfalls are likely to cross recreational beaches such as the 65-mile-long Padre Island National Seashore and cause temporary displacement of recreational use of the beach directly affected by pipeline construction. Onshore facilities associated with OCS routine operations most likely would be placed in commercially zoned coastal locations and would not impact recreation or tourism.

Accidents

Most barrier beaches in the Gulf of Mexico contain medium to coarse sand sediments. They are moderate- to high-energy environments with relatively low biological diversity; however, the esthetic and recreational values of these areas are high. The proposed action could result in oil spills from broken pipelines or from platforms in shallow water closer to shore. Oil from such spills could reach coastal areas. Oil coming ashore on a sandy beach may penetrate into the sand, the depth of penetration depending on the viscosity of the oil and the porosity of the sandy sediments. The oil may be buried by new sand or eroded from the surface of the beach, depending on whether the beach is building or receding. While oiled beach sediments are usually easily removed via mechanical means, such shoreline activity would effectively close the beach to public use for the duration of cleanup operations. If beach restoration is required (i.e., to restore the proper beach profile), additional time may be required before public access is allowed.

As noted previously, the primary impacts of oil spills are most likely to affect beach recreation, diving, commercial fishing, recreational fishing, and sightseeing activities. Historical evidence pertinent to the effects of major oil spills has indicated that spills may prompt either seasonal declines in tourist visits and/or tourist movement to other coastal areas in the region. Therefore, impacts from spilled oil on tourism and recreational activities and resources along the Gulf coast is expected to vary depending upon the volume of spilled oil, distance from the spill site to shore, the season, and the nature and extent of beach cleanup operations, including the amount of time a beach or coastal waters may be closed. While protected areas inshore of barrier beaches may be less susceptible to oil-spill impacts, spilled oil may reach into recreational areas within wetlands or protected embayments. On a local basis, an oil spill coming ashore would affect recreational resources located along coastal barrier beaches, with the possibility that protected embayments and wetlands might also be affected. As is the case with all oil spills, impact severity depends upon spill size, the nature of the oil coming ashore (e.g., highly vs. lightly weathered), the location and characteristics of the recreational resource, the season, the nature and extent of cleanup operations, and the amount of time a particular recreational area is closed due to cleanup and/or restoration activities. Impacts may be long term, depending upon spill location and relative sensitivity of the recreational resource affected (e.g., impacts to affected wetlands are generally greater than similar spill exposure on a barrier beach).

Conclusion: Routine operations will have **negligible** effects upon travel, tourism, and recreation. There may be slight impacts upon beach recreational activity due to esthetic degradation. If large oil spills were to occur and contact beaches, they would have **minor** effects upon tourism and recreation, unless a spill were to reach the coast during the peak of the beach recreation season, in which case impacts would be **moderate.**

4.3.2.15. Sociocultural Systems and Environmental Justice

Routine Operations

The more recent research discussed in Section 3.1.3.5. suggests that the effects of offshore oil and gas activities on the Gulf of Mexico sociocultural environment are not sweeping regional effects. The effects vary from one coastal community to the next. In some cases, the social organization of communities leaves them vulnerable to fluctuations in industry activity. In other cases, the local sociocultural structure buffers communities from industrial ups and down of all sorts—not the least of which is offshore oil and gas. Extrapolating outward to areas heretofore uninvolved in offshore oil and gas activity, one can postulate that the same sociocultural pattern will hold. Aggregate regional effects can be expected that belie the experiences of individual communities. In the face of expansions or contractions of offshore (or onshore) oil and gas activity, sociocultural systems in some communities will experience intense stress (moderate impact). Other communities will have the capacity to weather episodes of rapid industry change and may even thrive in doing so (negligible to minor impact).

Executive Order 12898 on environmental justice for minority and low-income populations was issued in 1994. It specifies that ". . . each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations" (59 FR 7629). Of course, disproportionately high and adverse human health or environmental effects can only occur onshore. Therefore, environmental justice concerns are mainly in regard to new onshore development related to offshore activities.

As noted in Section 3.1.3.5, three counties in the Gulf Coast region have been identified as very low-income areas: Union County, Florida; and Starr County and Willacy County, Texas. Moderately low income areas cluster in the panhandle of Florida, inland areas of east Texas, and near the border in south Texas. Substantial proportions of minorities also reside along the coast of the Gulf of Mexico. The Hispanic population tends to be concentrated in Texas and south Florida. The African-American population is a significant proportion of the population along the central Gulf Coast. Native Americans typically constitute less than 2 percent of the population, except in a handful of counties with up to 5 percent (Washington County, Alabama; Terrebonne Parish and Lafourche Parish, Louisiana; and Polk County, Texas).

The location of new onshore infrastructure is determined by industry based on economic and logistical considerations and is not regulated by the MMS. It is possible that new onshore infrastructure could be located near minority and/or low-income populations. The proposed action scenario includes the addition of new landfalls, new shore bases, and new waste facilities, with no new processing facilities. This onshore activity has the potential of creating environmental justice effects. Lafourche Parish, for example, is already serving as one of the only deepwater servicing facilities on the Gulf Coast. However, socioeconomic impacts occurring in supply and fabrication ports along the Gulf of Mexico are likely to have impacts at the community level rather than at a specific minority/low income group level.

Accidents

As noted previously, oil spills included in the proposed action may have local, short-term impacts on the natural and socioeconomic environment. Given the current level of existing oil and gas industry activity in the Gulf of Mexico Region, including experience with oil spills and spill response, impacts to sociocultural systems under the spill scenario would be negligible.

Conclusion: Routine operations associated with the proposed action would have **negligible** to **moderate** impacts upon sociocultural systems. It is possible that new onshore infrastructure could be located near minority and low-income populations and could produce adverse health or environmental impacts. However, at the programmatic level, it is not possible to identify any specific disproportionately high and adverse impacts on minority and low-income populations. Impacts on sociocultural systems due to accidents under the proposed action would be **negligible**.

4.3.2.16. Archaeological Resources

Archaeological resources in the Gulf of Mexico Region that may be impacted by the proposed action include historic shipwrecks and inundated prehistoric sites offshore, and historic and prehistoric sites onshore. Historic shipwrecks tend to concentrate in the shallow, nearshore waters of the Gulf of Mexico; however, numerous shipwrecks also occur scattered across the continental shelf and even in deepwater areas (Figure 3-21). Inundated prehistoric sites may exist on the continental shelf shoreward of about the 45-m isobath.

Onshore historic properties include sites, structures, and objects such as historic buildings, forts, lighthouses, homesteads, cemeteries, and battlefields. Onshore prehistoric archaeological resources include sites, structures, and objects such as shell middens, earth middens, campsites, kill sites, tool manufacturing areas, ceremonial complexes, and earthworks. Currently unidentified onshore archaeological sites would have to be assessed after discovery to determine the uniqueness or significance of the information that they contain. Sites already listed in the National Register of Historic Places and those considered eligible for the Register have already been evaluated as having the potential for making a unique or significant contribution to science.

Routine Operations

Routine activities associated with the proposal that are likely to affect archaeological resources include drilling wells, platform installation, pipeline installation and anchoring, as well as onshore facility and pipeline construction projects. While the source of potential impact will vary with the specific location and nature of the routine operation, the goal of archaeological resource management remains the protection and/or retrieval of unique information contained in intact archaeological deposits.

Direct physical contact between a routine activity and a shipwreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb the site context. The result would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel's crew, as well as the concomitant loss of information on maritime culture for the time period from which the ship dates. Ferromagnetic debris associated with OCS oil and gas activities could mask magnetic signatures of significant historic archaeological resources, making them more difficult to detect with magnetometers. Interaction between a routine activity and a prehistoric archaeological site could destroy artifacts or site features and could disturb the stratigraphic context of the site. The result would be the loss of archaeological data on prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts for North America, Central America, South America, and the Caribbean.

Regulations at 30 CFR 250.194 allow the MMS Regional Director to require that an archaeological report based on geophysical data be prepared, if there are indications that a significant archaeological resource may exist within a lease area. For historic resources, this decision is based on whether a historic shipwreck is reported to exist within or adjacent to a lease area (Figure 3-21). For prehistoric resources, all leases shoreward of the 45-m isobath are required to have an archaeological survey prior to initiating exploration and development activities. If the survey finds evidence of a possible archaeological resource within the lease area, the lessee must either move the proposed activity to avoid the possible resource or conduct further investigations to determine if an archaeological resource actually exists at the location. If an archaeological resource is present at the location of proposed activity and cannot be avoided, the MMS procedures require consultation with the State Historic Preservation Office to develop mitigating measures prior to any exploration or development.

Federal, State, and local laws and ordinances, including the National Historic Preservation Act and the Archaeological Resources Protection Act, protect known sites and also as-yet-unidentified archaeological resources. Existing regulations require archaeological surveys to be conducted prior to permitting any activity that might disturb a significant archaeological site. Therefore, most archaeological resources will be located, evaluated, and mitigated prior to any onshore construction. New data related to the human history and prehistory of the Gulf coastal region likely will be produced from compliance-related archaeological projects associated with the proposal.

It is assumed for this analysis that the level of protection provided by existing laws and regulations is in place. However, a routine activity could contact a shipwreck if the MMS failed to require a survey because of incomplete knowledge of the location of all historic shipwrecks in the Gulf of Mexico. Such an event could result in the disturbance or destruction of unique or significant historic archaeological information. It is less likely that an inundated prehistoric site would be contacted by a routine activity because archaeological surveys are required on all leases that have any potential for prehistoric site occurrence.

Accidents

An accidental oil spill resulting from the proposed action (Table 4-1e) could impact shipwrecks in shallow waters, and coastal historic and prehistoric archeological sites. Archaeological resource protection during an oil spill requires specific knowledge of the resource's location, condition, nature, and extent prior to impact; however, the Gulf of Mexico coastline has not been systematically surveyed for archaeological sites. Existing information indicates that, in coastal areas of the Gulf, prehistoric sites occur frequently along the barrier islands and mainland coast and the margins of bays and bayous. Thus, any spill that were to contact the land would involve a potential impact to a prehistoric site.

Should an oil spill contact a coastal historic site, such as a fort or a lighthouse, the major impact would be visual due to oil contamination of the site and its environment. This impact would most likely be temporary, lasting up to several weeks depending on the time required for cleanup. Gross crude oil contamination of shorelines is a potential direct impact that may affect archaeological site recognition. Heavy oiling conditions (Whitney, 1994) could conceal intertidal sites that may not be recognized until they are inadvertently damaged during cleanup. Crude oil may also contaminate organic material used in ^{14}C dating, and, although there are methods for cleaning contaminated ^{14}C samples, greater expense is incurred (Dekin et al., 1993). An Alaskan study examining the effects of the 1989 *Exxon Valdez* oil spill on archaeological deposits revealed that oil in the intertidal zone had not penetrated the subsoil, apparently due to hydrostatic pressure (Dekin et al., 1993); however, due to the different environments, these results should not be translated into the Gulf Coastal environment without further study.

The major source of potential impact from oil spills is the harm that could result from unmonitored shoreline cleanup activities. Unmonitored booming, cleanup activities involving vehicle and foot traffic, mechanized cleanup involving heavy equipment, and high pressure washing on or near archaeological sites pose risks to the resource. Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with effective training and supervision. As Bittner (1996) described in her summary of the *Exxon Valdez* oil spill: "Damage assessment revealed no contamination of the sites by oil, but considerable damage resulted from vandalism associated with cleanup activities and lesser amounts were caused by the cleanup process itself."

The National Response Team's *Programmatic Agreement on Protection of Historic Properties During Emergency Response Under the National Oil and Hazardous Substances Pollution Contingency Plan* clarifies interagency and regulatory aspects of archaeological site protection during oil-spill response. This 1997 agreement outlines the Federal On-Scene Coordinator's responsibility for ensuring that historic properties are appropriately considered in planning and during emergency response.

Conclusion: Assuming compliance with existing Federal, State, and local archaeological regulations and policies, most impacts to archaeological resources resulting from routine activities under the proposal will be avoided. Therefore, only a **minor** level of impacts to archaeological resources are anticipated from routine operations. Based on the scenario for the proposal, some impact could occur to coastal historic and prehistoric archaeological resources from accidental oil spills. Although it is not possible to predict the precise numbers or types of sites that would be affected, contact with archaeological sites would probably be unavoidable, and the resulting loss of information would be irretrievable. The magnitude of the impact would depend on the significance and uniqueness of the information lost, but based on experience gained from the *Exxon Valdez* oil spill, the impact would most likely be **minor** to **moderate**.

4.3.3. Alaska Region

4.3.3.1. Water Quality

4.3.3.1.1. Marine Waters

Routine Operations

During exploration, construction, production, and decommissioning phases, activities include dredging for pipelines, possible construction of artificial islands, placement of platforms, and subsequent removal of these structures. These activities will disturb the seafloor and increase the suspended sediment load in the water column. Estimated areas of seafloor disturbed by these structures range from less than 10 ha to several hundred per planning area in Alaska (Table 4-1b). Such suspended sediments have a very low toxicity for sensitive species; expected toxicity ranges between clay, like bentonite (LC_{50} [lethal concentration resulting in 50% mortality of test organisms] > 7,500 ppm for the eastern oyster) and calcium carbonate (LC_{50} > 100,000 ppm for the sailfin molly [National Academy of Sciences, 1983]). These ranges are generally described as slightly toxic to nontoxic.

Dredging trenches for pipelines and constructing artificial islands increases water turbidity. Offshore pipelines in Alaska are normally placed in a dredged trench in waters less than about 60 m. Dredged material from the trenches can be used to cover the pipeline. Fill deposited during artificial island construction also increases turbidity. As these operations are reversed and structures removed, increased turbidity will reoccur. Generally, plumes from these activities extend a few hundred meters to a few kilometers down current (Pessah, 1982), but plume length will depend on current regime, source type, and water column turbulence. For example, a plume 0.7-1.0 km long would result from dredging for a pipe in the Chukchi Sea that transects the Alaska Coastal Current (the coastal current flows about 0.36 km/hr [Weingartner, 1997]). Season, sediment grain size, and rate and duration of discharge will influence turbidity and plume size within these disturbed areas. In Norton Sound, some of the seafloor sediment is contaminated with trace metals (e.g., mercury and arsenic) near Nome due to gold mining (USDOI, MMS, 1996a). Pipeline dredging in this area may temporarily release some of these metals locally. Overall, it is anticipated that the temporary, additional suspended sediment load will have minor impacts on water quality.

Production platforms currently used in Cook Inlet State waters consist of a deck (or decks) supported by legs and cross members that rest on pilings driven into the seafloor. Placement and removal of platforms disturb bottom sediments on a small scale. Increases in ambient turbidity will result from legs and pilings placed on and/or removed from the substrate. On a still smaller scale will be turbidity from setting and retrieving work vessel anchors (used to control the movement of vessels while dredging and setting pipes or placement of platforms). This type of disturbance would also occur if drillships were to used, a standard procedure in Chukchi Sea exploration. Impacts on water quality from these temporary operations will be negligible to minor.

Routine operations associated with all phases of operations affecting water quality will include effluents from domestic waste (e.g., washing, sewage, food preparation) and deck drainage (platform and deck washings, runoff from curbs, gutters and drains, including drip pans and work areas). It is estimated that 6,000 gallons per day (gpd) of domestic wastes are discharged from a typical exploration vessel and 5,000 gpd from a development platform (USDOI, MMS, 1996c). Domestic waste will increase suspended solids, therefore increasing turbidity and biological oxygen demand. Established effluent limitations and guidelines published in the Code of Federal Regulations (40 CFR Part 435) and operator compliance should reduce the impacts of domestic discharges and deck drainage on ambient water quality to a minor level.

During drilling, the principal discharges of concern are drilling muds and cuttings. The quantity of muds and cuttings will be dependent on the number of exploratory, delineation, development, and production wells and well depths. During drilling, cuttings are removed from the hole, separated from drilling muds, and discharged into the water. These two sources of turbidity might be characterized as forming two plumes when discharged. The heavier materials settle to the seafloor slightly down current of the discharge point. In shallower waters such as the Beaufort and Chukchi Seas, this may occur as a plume within 100 m of the discharge point, consisting primarily of cuttings, and may reach background levels within 1,000 m. In deeper waters and areas with rapid currents (e.g., Cook Inlet), the affected water column and substrate may be more extensive, but there may be less of an impact due to dilution. The increased turbidity will cease quickly after cessation of discharge. Impacts of drilling-related discharges will range from negligible to minor**,** depending on the number of wells drilled, water depth, current velocities, and turbulence in the area.

Muds, and their potentially toxic trace elements, vary greatly and tend to rapidly dilute over space and time. Concentrations are typically reduced three or four orders of magnitude within 100 m of discharge point (USDOI, MMS, 1996a). The potential toxic trace elements in drilling muds include arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, vanadium, and zinc. Drilling muds used offshore Alaska are of relatively low toxicity; constituents are limited within the applicable NPDES permit. Exploration discharges are not likely to exceed applicable water quality criteria outside of a 100-m radius, or 0.03 km^2 around each drill site. Effects of exploration discharges on water quality would persist for a few hours within the 100 m radius mixing zone around each rig. Under the proposed action, discharge of muds and cuttings would degrade water quality in an extremely limited area (i.e., < 1% of each planning area). Assuming maximum discharge rates are limited by EPA to the same extent during production as exploration, production-drilling discharges would be of the same order of magnitude and will have negligible to minor impacts on water quality.

Produced water (the total water discharged from oil and gas extraction, including formation water, water from rock strata, and injection water if used for secondary oil recovery) will be of primary concern during the production phase. During initial oil production, formation water volumes represent a small fraction (< 1%) of total liquid extracted. As a reservoir is depleted, the ratio of formation water to oil increases and may reach 10 to 1 in the produced water. It is assumed that all produced waters from the proposed activities will be reinjected. The constituents of concern in produced water that may adversely affect water quality are entrained oil or petroleum hydrocarbons, high trace metal concentrations, and low dissolved oxygen concentrations, and NORM. Impacts on water quality are generally low due to rapid dilution and dispersion, limiting the effects usually to within meters of the discharge source (USEPA, 1993). However, under-ice conditions, as in the arctic planning areas, the reduced currents would reduce this dilution and dispersion. Compliance with NPDES permit restrictions is assumed to minimize impacts on receiving waters. Water quality would recover without mitigation when discharges cease. Furthermore, most major production facilities, such as the Northstar facility in the Beaufort Sea, would be reinjecting all muds, cuttings, and production waters, thus eliminating degradation of water quality by these effluents. Impacts on water quality from produced waters are expected to be minor.

Accidents

Marine water quality would be affected primarily by any of the large oil spills in the proposed action scenario and, to a lesser degree ,from the more numerous small spills (Table 4-1e). Pipeline spills (4,600 bbl) are assumed for the Beaufort Sea, Chukchi Sea, and Cook Inlet Planning Areas; a platform spill (1,500 bbl) in the Beaufort Sea and Chukchi areas; and a possible tanker spill (7,800 bbl) in the Gulf of Alaska area. Large spills generally result in peak, dissolved hydrocarbon concentrations that are usually only marginally above toxic levels within a localized area (USDOI, MMS, 1996a). For example, volatile liquid hydrocarbons from the *Ixtoc I* spill decreased from 0.4 ppm near the blowout to 0.06 ppm at a 10-km distance, and to 0.0004 ppm at a 19-km distance from the blowout. If a spill were to occur under the ice, as from a pipeline break in the arctic planning areas, oil would likely be frozen into the ice and not weather until seasonal melt-out begins.

Decomposition and weathering processes for oil are slowed appreciably in cold water. Sustained degradation of water quality from hydrocarbon contamination to levels above State and Federal criteria is possible, but will depend on the exposure to currents, wind, temperature and turbulence. Seasonality and the specific spill location will cause variability in effects (e.g., summer vs. winter in the Beaufort and Chukchi Seas; Beaufort and Chukchi Seas vs. the Gulf of Alaska). In open marine waters, advection and dispersion generally reduce the effects of toxic oil fractions and their daughter products to below State and Federal criteria for hydrocarbon contamination. Sustained degradation of water quality to levels exceeding the chronic criterion of 0.015 ppm total hydrocarbon contamination is unlikely. However, levels could exceed this standard over several thousand square kilometers for a short period of time (about 30 days), depending upon the size, location, and season of the spill event. The persistence of oil slicks would generally be less than one year.

Large oil spills assumed under the proposed action could affect water quality in any of the planning areas (except Norton Basin), and the impact would be unavoidable. The resource would eventually recover, but recovery may be enhanced through oil-spill cleanup. Thus, the impact is considered minor to moderate. Small oil spills (Table 4-1e) or oil condensate in gas would also produce measurable impacts on water quality, but would more rapidly recover without mitigation due to evaporation and weathering. Their impacts would be minor.

4.3.3.1.2. Coastal Waters

Routine Operations

Construction of a new onshore support facility (Chukchi/Hope Basin and Norton Basin) and pipeline landfalls (three in the Chukchi/Hope Basin and one each for the Beaufort. Cook Inlet, and Norton Basin areas) may affect the quality of nearshore and fresh waters. Dredging associated with pipeline burial in coastal waters would result in some increased suspended sediments and turbidity. As previously discussed for marine waters, the impacts on water quality would be temporary and minor.

During land site preparation, the vegetation is typically cleared from the area, and the topsoils are compacted by the constant movement of heavy machinery. This reduces water retention properties of the soil and increases erosion and runoff from the site. The volume and rate of runoff increase as the natural vegetation is modified. Water quality will be affected by increases in site runoff of particulate matter, heavy metals, petroleum products, and chemicals to local streams, estuaries, and bays. Proper siting of facilities and requirements associated with construction permits should largely mitigate these impacts. Depending on the site locality, construction, and mitigation, the impacts on water quality should have negligible or minor consequences.

Accidents

A nearshore oil spill would impact water quality as it would offshore. However, a coastal accident (i.e., a pipeline spill in shallow water) could introduce contaminants into smaller reservoirs of fresh or marine waters where it could have a greater impact due to minimal dilution. In marine waters advection and dispersion would reduce the effects of released toxic-oil fractions or their breakdown products. However, this would depend on the size, location, and season of the spill. A spill in isolated coastal waters, or shallow waters under thick ice, or in rapidly freezing ice, could cause sustained degradation of water quality to levels above State and Federal criteria for hydrocarbon contamination. Concentrations could exceed the chronic criterion of 0.015 ppm total hydrocarbons, but this would probably occur over a relatively small area. Persistent small spills in such areas could result in local chronic contamination. In most cases, spills would be rapidly diluted and would have only minor effects on water quality. In some cases, as described above, water quality may be degraded to a greater extent, resulting in moderate impacts to small areas.

The estimated probability of one or more large spills (500 bbl or greater) occurring from the proposed action is provided in Table 4-1e. The probabilities for such a large spill occurring are estimated as 16-18 percent (Cook Inlet), 81-94 percent (Beaufort Sea), and up to 98 percent (Chukchi Sea).

Conclusion: Overall marine and coastal water quality impacts due to routine activities from the proposed action would be **negligible** to **minor**. If large accidental oil spills were to occur, they would likely result in **minor** impacts to marine and coastal water quality. However, **moderate** impacts are also possible in situations where the oil would persist without cleanup.

4.3.3.2. Air Quality

4.3.3.2.1. Routine Operations

The most commonly emitted air pollutants associated with Alaska OCS oil and gas activities include NO_x, SO_2, PM_{10}, CO, and VOC. A discussion of the general effects of these pollutants and the various types of OCS sources may be found in Section 4.3.2.2. The OCS facilities off Alaska are under the jurisdiction of the USEPA according to the regulations in 40 CFR Part 55. For facilities located within 25 miles of the State's seaward boundary, the regulations are the same as would be applicable if the emission source were located in the corresponding onshore area, and would include State and local requirements for emission controls, emission limitations, offsets, permitting, monitoring, testing, and monitoring. For facilities located beyond 25 miles of a State's seaward boundary, the basic Federal air quality regulations apply, which include the USEPA emission standards for new sources and the PSD regulations. Facilities are required to use best available control technology (BACT).

The OCS operations in the Beaufort and Chukchi Seas are unique in a number of ways due to the sea ice that is present much of the year. In very shallow waters, exploratory wells may be drilled from a gravel island or from a movable platform resting on the seafloor (USDOI, MMS, 1998b). Construction of an ice island would need to take place in winter, and material and personnel would be carried to the site by vehicles operating on an ice road. Installation of a movable platform would need to take place during the short ice-free season. However, drilling operations could take place all year.

In deeper waters where drillships or floating platforms would need to be used, drilling would be limited to a short period in the summer months. Material and supplies would be ferried using barges or supply boats. In addition, icebreakers would operate in the vicinity of the drilling rig and vessels to control sea ice. Because of the arctic conditions, the pace of development is slower as activities are limited to certain, rather narrow, time frames. However, air emission rates tend to be higher because activities are more concentrated and additional vessels such as icebreakers are needed. In shallow waters, production may take place from gravel islands or bottom-founded structures, while in deeper waters floating structures anchored to the seafloor would be used. As in the case of exploration, the gravel island would be constructed in winter. The modules for the production facilities would be installed during the ice-free period using barges, tugboats, and supply vessels.

In the Hope and Norton Basins, operations would not be nearly as restricted by ice as would be the case in the Arctic Ocean, while the Cook Inlet experiences open-water conditions throughout the year. In these areas, OCS operations would be more similar to those in other OCS areas.

Projected 5-Year Program Air Emissions

Air emissions associated with the proposed 5-year program were estimated using emissions scenarios that were developed by Jacobs Engineering Group (1989). For the Beaufort and Chukchi Seas, some of the emissions estimates were derived from projections associated with recent exploration and production plans in the arctic, notably the Northstar and Liberty projects. Peak annual emissions were not estimated due to the considerable uncertainty in the timing of the various activities. Table 4-8d shows estimated emissions for the various phases of operations. In the Beaufort and Chukchi Sea Planning Areas, the highest emissions would be associated with exploration activities. Any gravel island construction would also be a large source of emissions, while platform installation in open waters would result in relatively lower emissions. Emissions during the production phase would be highest during the peak production years and then would gradually decrease over time.

Impacts from Nitrogen Dioxide (NO_2), SO_2, PM_{10} , and CO

Air quality modeling has been performed in the past to assess impacts from planned lease sales in the Beaufort Sea (USDOI, MMS, 1998b; USDOI, MMS, 1996c), Chukchi Sea (USDOI, MMS, 1991a), Norton Basin (USDOI, MMS, 1985), and Cook Inlet (USDOI, MMS, 1995b) Planning Areas. The highest predicted annual average NO_2 concentrations were in the range of 0.5 to 1.5 $\mu g/m^3$, which is very small compared with the PSD Class II maximum allowable increase of 25 $\mu g/m^3$. Concentrations of SO_2 and particulate matter were not modeled; however, when one scales the results according to the respective emission rates, the levels would be well within the PSD Class II increments. Modeling for recent planned development projects in the Beaufort Sea (USDOI, MMS, 2001; U.S. Army Corps of Engineers, 1999) resulted in higher concentrations. In these cases, concentrations were modeled for points just outside the facility boundary, but the levels predicted for NO_2, SO_2, and PM_{10} were still within the PSD limits. The proposed 5-year program would result in a rather slow rate of development involving a small number of facilities that would be spread over a wide area. Each project would need to apply BACT, and associated pollutant concentrations would have to meet the PSD incremental limits. Existing pollutant concentrations in coastal Alaska are well within the NAAQS. The small additional concentrations from the proposed 5-year program activities would result in levels that are still well within the ambient standards.

The Tuxedni National Wilderness Area in Cook Inlet is a PSD Class I area, which has more stringent limits on concentrations than Class II areas. Air quality modeling for the Cook Inlet Planning Area (USDOI, MMS, 1995b) showed a highest NO_2 concentration of 0.5 $\mu g/m^3$. This is well within the

PSD Class I incremental limit of 2.5 μg/m^3. Activities associated with the proposed 5-year program should be able to meet the Class I standards.

In summary, the concentrations of NO_2, SO_2, and PM_{10} would be within the applicable maximum allowable increases. The concentrations of NO_2, SO_2, PM_{10}, and CO would remain well within the NAAQS. The impacts from the proposed 5-year program on the pollutant levels would be minor.

Ozone

Ozone is formed in the atmosphere through photochemical reactions involving primarily NO_x and VOC. Ozone formation is most favorable when there are relatively large sources of NO_x and VOC in the area, the atmosphere is stable, there is a considerable amount of solar radiation, and temperatures are high. Conditions in Alaska are seldom favorable for significant ozone formation. Emissions from the proposed 5-year program would be relatively small and dispersed and located far from major population centers. Ambient ozone levels are within the Federal standard in all areas of Alaska. The impacts from the proposed 5-year program activities would be negligible.

Visibility

Gaseous and fine particulate matter in the atmosphere can potentially degrade atmospheric visibility. The most important source of visibility degradation is from particulate matter in the 1- to 2-micron size range. These particles are directly emitted into the atmosphere through fuel burning. However, other sources arise through chemical transformation of NO_2, SO_2, and VOC into nitrates, sulfates, and carbonaceous particles. Existing visibility in Alaska is generally good because of the absence of large emission sources. The phenomenon of arctic haze, which occurs in northern Alaska in winter, is attributed primarily to long range transport of pollution sources from the Eurasian continent. A screening model for visibility was applied to a planned OCS facility in the Beaufort Sea. It found a noticeable effect on only a very limited number of days, ones that had the most restrictive meteorological conditions. No effects were simulated during average conditions (USDOI, MMS, 2001). The screening method overestimates impacts so it is unknown if the modeled impacts are real. It is not known to what extent aggregate OCS sources contribute to visibility reductions. However, the individual emission sources from the proposed 5-year program are relatively small and scattered over a large area, and it is not expected that, as a whole, they would have a measurable impact on visibility. The impacts on visibility from the proposed 5-year program would be negligible.

4.3.3.2.2. Accidents

Small accidental oil spills would cause small, localized increases in concentrations of VOC due to evaporation of the spill. Most of the emissions would occur within a few hours of the spill and would decrease drastically after that period. Large spills would result in emissions over a large area and a longer period of time. A discussion of the effects of oil spills on air quality is presented in Section 4.3.2.2. A spill in the Arctic Ocean during broken ice or melting ice conditions could result in more concentrated emissions over a smaller area than would be the case under open-water conditions. In a large spill occurring under the ice, the oil would remain trapped and be dispersed under the ice until melting or breakup occurs. Emissions would then occur at a slower rate and would already be dispersed over a wider area before it starts.

In situ burning of a spill results in emissions of NO_2, SO_2, CO, and PM_{10} and would generate a plume of black smoke. A discussion of the effects of in situ burning is presented in Section 4.3.2.2. Studies of in situ burn experiments have shown that air quality impacts are localized and short-lived and pollutant concentrations do not pose a health hazard to persons in the vicinity.

In summary, any air quality impacts from oil spills would be localized and of short duration. Emissions do not appear to be hazardous to human health. The impacts from in situ burning are also very temporary. Pollutant concentrations would not be expected to be within the NAAQS. The air quality impacts from oil spills and in situ burning would therefore be minor.

Conclusions: The impacts of routine operations from the proposed 5-year program on levels of NO_2, SO_2, PM_{10}, CO, and ozone would be **minor**. Air quality impacts from accidental oil spills or in situ burning would be **minor**.

4.3.3.3. Marine Mammals

4.3.3.3.1. Cetaceans

Routine Operations

Of the seven federally listed cetacean species occurring in Alaskan waters (Table 3-19) all but the bowhead (*Balaenoptera mysticetus*), fin (*B. physalus*), and humpback (*Megaptera novaeangeliae*) whales are considered relatively rare within the Alaska OCS Planning Areas. It is likely that OCS activities will affect cetacean species similarly. Therefore, the following discussion focuses on these three species of most concern. Any notable differences among cetacean species and their responses to relevant impact factors are brought out in the discussion as necessary. The main impact factor associated with the routine operations of the proposed action that may affect cetaceans in Alaska is noise associated with prelease and postlease surveys, drilling and production, and decommissioning and abandonment activities. Other impact producing factors, including operational discharges and wastes and vessel and aircraft traffic, are not expected to produce measurable impacts on cetacean species in Alaska. Table 4-1b presents proposed action scenario elements that are the basis for this impact analysis.

Noise produced by routine industrial activities associated with OCS oil and gas development (Table 4-1b), such as vessel and aircraft traffic, drilling, drill ship operations, seismic surveys, dredging, pipeline construction, and production operations, may affect migrating bowhead whales. The proposed action calls for 18-30 and 6-24 exploration and delineation wells to be drilled in the Beaufort and Chukchi Seas, respectively. While most exploratory activities in the Chukchi Sea are conducted during the open-water season, many exploratory activities in the Beaufort Sea have occurred during the winter. Bowheads would be present in the later stages of the open-water season. Depending on ice conditions, exploration activities may coincide with the bowhead migration.

A presentation by Burton Atqaan Rexford summarizes local and traditional knowledge on possible noise effects upon bowhead whales within the context of subsistence whaling:

Like many other Eskimo whaling captains, it is with great care and much thought that I submit my factual findings from actual experiences. Throughout my 53 years of whaling in villages ranging from Point Hope, Barrow, and Point Barrow (Nuvuk), I have personally, like many other whalers, observed the impact of noise interference on bowhead whales. In the spring, when we hunt in the ice leads, we must use the umiaq, made of bearded seal skin. The umiaq is light to carry when you travel to the ice edge and it is silent in the water. You cannot use an aluminum boat in the ice leads because the sound of the water on the side of the boat will scare the bowhead whale. You must paddle silently in the water because the sound of the paddle in the water will scare the bowhead. You must wear white parkas on the ice because if you don't the whales will see you when they surface. These are only some of the things that a whaler must know. There are many other things, but the most important is to respect the whale and its home (World Council of Whalers News, 2000).

This testimony contains not only observations on bowhead whales' sensitivity to audio and visual disturbance, but also speaks to the cultural centrality of bowhead whales and whaling for the Inupiat.

Bowhead whales have very sensitive hearing. While bowheads exhibit avoidance behavior at many manmade sounds, there remains considerable debate on their range of sound detection. Bowhead whales have exhibited avoidance behavior to noise producing activities (Richardson and Malme, 1993). The proposed action assumes up to two vessel trips per week in the Beaufort and up to four in the Chukchi/Hope Basin Planning Area. Bowheads typically avoid vessels at distances ranging from 1 to 4 km (and Inupiat whalers report their boats with motors, used only during the fall bowhead migration, affect whales at distances of no less than 3 miles—Thomas P. Brower 1978, as cited in Section 3.2.3.5.1). However, bowheads have been sighted within 0.2 to 5 km of drillships. Drilling noise from a drilling ship may deflect individuals 20 km or more from their migratory path. Schick and Urban (2000) suggest that the spatial pattern of bowhead distribution is highly correlated with distance from drilling rigs. They further suggest that the presence of drilling rigs resulted in a significant temporary loss in available habitat. Accompanying icebreakers, which produce louder noise, may mask noise produced by drill ships. While there have been no direct observations of bowheads reacting to icebreakers, it is estimated that approximately half of the individual bowheads within 4.6 to 20 km of the source would show an avoidance response to an icebreaker pushing ice when the signal-to-noise ratio is 30 dB (Miles et al., 1987). Bowhead whales are capable of detecting sounds of icebreaker operations at a range of up to 50 km (31 miles) (Richardson, 1996). Bowheads do not seem to respond adversely to aircraft overflights at altitudes greater than 300 m. In general, bowheads do not appear to deflect more than a few kilometers in response to a single noise disturbance, and behavioral responses last only a few minutes. Typical behavioral reactions include a change in migration speed and swimming direction to avoid the sound source (Richardson et al., 1991a). Because the main bowhead migration corridor is 10 km or more seaward of the barrier islands, drilling and production noise is not likely to reach many migrating whales unless production platforms are established farther offshore in the Beaufort Sea.

The proposed OCS activities would result in increased aircraft and vessel traffic in areas where fin and humpback whales may be present. In the Chukchi Sea, 10-40 helicopter trips per week and 1-4 vessel trips per week are assumed as part of the proposed action. There have been no systematic studies on the effects of aircraft overflights on humpbacks or fin whales. However, observations indicate that large groups of humpbacks showed little to no response to small aircraft, while groups containing only adults showed some avoidance (Herman et al., 1980). Fin whales reacted slightly to small aircraft circling at 50-300 m (Watkins, 1981). Helicopter traffic is probably more disruptive, but there are few data available on the effects of helicopter overflights on either species. Support vessel traffic would most likely affect fin whales similar to bowheads, altering behavior under certain situations. Fin whales reduced the duration of surfacing and dives, and had fewer blows per surfacing when whale watching vessels were nearby (Young, 1989; Stone et al., 1992). Bauer et al. (1993) concluded that overall, humpbacks attempted to avoid vessels and that pods containing calves were more affected than larger pods.

Noise from routine industrial activity, in general, is expected to affect sperm whales (*Physeter macrocephalus*) in the same manner as other large whales. Sperm whales have shown a variety of responses to aircraft overflights, ranging from no reaction to rapid diving (Clarke, 1956; Gambell, 1968; Mullin et al., 1991). In addition, they show similar varied responses to vessel traffic (Gaskin, 1964; Reeves, 1992).

There is little information on the reaction of minke whales (*Balaenoptera acutorostrata*) to aircraft overflights. Leatherwood et al. (1982b) observed minke whales responding to an H-52 turbine helicopter at 230 m altitude by changing course, rolling onto their sides, or slowly diving. There have been other reported incidents where minke whales have appeared disturbed by helicopter activity (Ljungblad et al., 1982a; Bird, 1983; Bauer and Herman, 1986). Minke whales have varied responses to vessel activity. Some individuals are wary of vessels (Macfarlane, 1981), while others actively approach and swim under vessels (Winn and Perkins, 1976; Leatherwood et al., 1982b). However, minke whales generally tend to avoid moving vessels.

There have been reports of short-term behavioral reactions in odontocetes to aircraft and vessel traffic. Responses to aircraft include turning away, abruptly diving, and looking towards the aircraft (Malme et al., 1989). Potential behavioral responses to vessel traffic could include altering swimming speed and moving away from the vessel.

Routine aircraft and vessel activity may temporarily disturb killer whales (*Orcinus orca*). Avoidance of vessels should not be at distances greater than 400 m (Kruse, 1991b). Belugas (*Delphinapterus leucas*) have shown variable reactions to fixed-wing aircraft and helicopter overflights (Richardson et al., 1991b). Some show no overt response, whereas others look upward, dive abruptly, or turn sharply away when aircraft flies over at altitudes up to 460 m. Inupiat hunters have expressed concern that low flying aircraft have kept belugas from entering an Alaskan bay (Burns and Seaman, 1985). Disturbance of harbor (*Phocoenoides phocoena*) and Dall's porpoises (*Phocoenoides dalli*) by aircraft appears to cause temporary, localized behavioral reactions. Dall's porpoises dove, moved erratically, or rolled to look upward at an overflying Bell 205 helicopter at a 215- to 365-m altitude (Withrow et al., 1985).

Belugas display a variety of behavioral responses to vessel traffic, ranging from tolerance to extreme sensitivity. Reactions depend greatly on the whale's behavior, habitat, boat type, and boat activity. The proposed action assumes 2-8 vessel trips per week in the Cook Inlet. In areas where belugas are hunted by boat, such as Cook Inlet, small vessel traffic has been known to alter local distribution (Seaman and Burns, 1981; Burns and Seaman, 1985; Caron and Smith, 1990). Conversely, larger vessels traveling in a consistent direction are tolerated greatly by belugas (Fraker, 1977; Macfarlane, 1981; Sergeant, 1981, 1986; Burns and Seaman, 1985; Pippard, 1985). However, Lesage et al. (1999) found that a significant decrease in the calling rate of beluga whales occurred during exposure to both a small boat and a ferry in the St. Lawrence estuary, indicating more effect than was detected during visual observations. Lesage et al. (1999) hypothesized that decreases in the calling rate of belugas observed during ferry approaches might be due to a greater acoustic overlap in the call frequency used by belugas and the source frequencies of the ferry. During spring, noise from ships and icebreakers in deep channels of the Canadian high arctic caused belugas to flee when a ship approached within 35-50 km (LGL and Greeneridge, 1986; Cosens and Dueck, 1988; Finley et al., 1990). Belugas typically traveled up to 80 km from the ship's path and remained away from the area for 1-2 days. However, it should be noted that, in areas such as Bristol Bay, increased fishing vessel and spotter aircraft traffic during the salmon fishing season do not appear to displace beluga whales from feeding habitat. Porpoises tend to tolerate or even approach vessels, but when harassed, they may avoid vessels.

Sound produced by seismic exploration can also disturb bowhead whales. There are two types of seismic surveys: low-resolution deep seismic and high-resolution shallow seismic surveys. High-resolution seismic surveys are low energy and produce very little sound. These activities probably do not significantly impact bowhead or other endangered whales. In contrast, low-resolution deep seismic surveys produce loud pulsed sounds, which can propagate 25 to 50 km from their source. Within a few kilometers of seismic operations, most whales show strong avoidance and changes in surfacing, respiration, and dive patterns (Richardson et al., 1986; Ljungblad et al., 1988). Strong avoidance occurs when received levels of seismic noise are 150 to 180 decibels (dB) re 1 micropascal (μPa) (Richardson and Malme, 1993). Behavioral reactions to seismic activities are generally thought to be minor and end shortly after cessation of the seismic activity. New information on the effects of seismic noise on bowheads is now available from monitoring programs conducted in 1996-1998 (Miller et al., 1997 and 1999; Miller, Elliot, and Richardson, 1998). Seismic operations conducted since 1996 generally have been 3-D seismic programs using ocean-bottom cables in the nearshore waters of the central Alaskan Beaufort Sea. These recent studies indicate that bowheads tend to avoid the area around the operating source, to a radius of about 20 km. Results of the 1996-1998 studies show that bowheads were rarely seen within 20 km of the operations area at times when the airguns were operating, but there were some sightings within 20-30 km of the nearest shotpoint (Miller et al., 1999). Within 12-24 hours after seismic operations ended, the sighting rate within 20 km was similar to the sighting rate beyond 20 km.

From a local perspective, Fred Kanayurak reported "But things have been difficult at times since seismic activity has started. We know for sure that whales were diverted to migrate in a different route than what the original migration route was" (USDOI, MMS, 1997). Other whaling captains, at this same session, related their observations and personal experiences on the effects of seismic operations, which they stated disturbed normal whale behavior and disrupted whaling activities for significant periods of time, and sometimes for an entire whaling season (from Nuiqsut: Thomas Napageak, Archie Ahkiviana, Roxy Oyagak Jr., Eli Nukapigak, George Taalak for Sam Taalak; from Kaktovik, Joseph Kaleak; from Barrow: Van Edwardsen, Ben Itta, Harry Brower Jr., Burton Rexford, and Arnold Brower Jr.—USDOI, MMS, 1997).

In general, fin and humpback whales are expected to react similarly to bowhead whales in response to seismic noise. Fin whales were observed about 36 km from a seismic boat behaving normally in the presence of seismic noise at a level of 150 dB re 1 μPa. Malme et al. (1985) studied the reaction of humpbacks to seismic noise. Some individuals reacted to seismic levels of 150-169 dB re 1 μPa at up to 3.2 km. However, there was no conclusive evidence that humpbacks avoided seismic sound sources at levels up to 172 dB re 1 μPa. Minke whales are expected to respond like other baleen whales, with general avoidance and varied behavioral responses. Seismic exploration is expected to only elicit short-term avoidance in minke whales (Malme et al., 1989). Nearby seismic vessels have deflected migrating gray whales (Fidel et al., 1970).

There are limited observations on the effects of seismic activity on odontocetes. Most airgun arrays produce high-energy sounds below 100 Hz, which is below the frequencies of the call and optimum hearing of odontocetes. Therefore, it is possible that belugas and killer whales would not be greatly affected by seismic noise. However, overall received levels of airgun pulses are often greater than or equal to 130 dB re 1 μPa, which could be detected, perhaps displacing individuals temporarily. Sperm whales may have displayed some vertical avoidance to sound sources during the Acoustic Thermometry of Ocean Climate Project by remaining at the surface for longer intervals (National Research Council, 2000). Sperm whales are deep divers that use low frequency sound for communication. It is possible that low-frequency sounds produced by seismic exploration could mask communication among whales. Impacts on harbor or Dall's porpoises should be limited to 10-20 km from the source, and should be temporary with short-term avoidance of the source area.

Reactions to dredging vary among individual bowheads. Whales exposed to experimental dredge sounds of 122-133 dB exhibited avoidance behaviors. Bowheads stopped feeding and moved from within 0.8 km of the sound source to locations greater than 2 km away (Richardson et al., 1990). However, whales further away exhibited only weak and inconspicuous avoidance. A gradual onset of dredge noise produced less abrupt reactions. There is some indication that some individuals may habituate to dredging and other construction activities.

Reactions of bowheads to oil production noise (i.e., drilling) within the spring lead system were similar to their reactions to exploration noise (Richardson et al., 1990). Richardson et al. (1995a) concluded that bowheads tolerated high levels of continuous drilling noise when necessary to continue with migration. Their migration was not blocked, nor was there any indication that they avoided the sound source by more than 1 km. However, individual bowheads altered their movement patterns and behavior in response to drilling noise. Local Inupiat are concerned about drilling noise effects. Thomas Brower Sr. spoke about the spring 1978 whaling season when Barrow took only four whales, saying "The gravel island drilling at this time may make it impossible for the [whaling] captains to supply [the village] with needed winter food supplies" (as cited in USDOI, MMS, 2000d).

Gray whales have been observed to react to noises similar to bowheads. If, in fact, migrating bowheads react in the same way to production platform noise as gray whales (Malme et al., 1984), then bowheads would be expected to respond by altering their migration speed and swimming direction to avoid approaching these platforms closely. Subsistence whalers have stated that noise from some drilling activities displaces whales farther offshore, away from their traditional hunting areas (USDOI, MMS, 2001).

Fin, humpback and gray whales are expected to respond similarly to bowheads to drilling, drill ships, and production noises. They are expected to avoid operational noise producing activities by 1 to 4 km. Avoidance reactions can occur at a 10 to 20 km distance. Noises produced by routine industrial activities would most likely disturb gray whales during their spring migration through the Chukchi and Bering Seas and along the coast of Alaska.

Odontocetes are expected to be relatively tolerant of drilling and production noise. Belugas are probably most sensitive to drilling activities in the spring, when they are migrating along open leads in the ice. Belugas in leads changed course when they came within 1 km of a stationary drill ship. In addition, they actively avoided support vessels moving near the drill ship (Norton-Fraker and Fraker, 1982). Additional stress on the Cook Inlet stock of beluga whales caused by routine operations under the proposed action may reduce fitness and survivorship. Killer whales are also expected to be relatively tolerant, as other species of odontocetes have been observed close to drilling operations (Kapel, 1979; Sorensen et al., 1984). Harbor and Dall's porpoise reactions are expected to be similar to killer and beluga whales, including avoidance of the immediate and surrounding areas. Sperm whales are usually found in waters deeper than 200 m and are relatively rare within the Alaska OCS oil and gas planning areas; therefore, any effects caused by industrial activities should be negligible.

Accidents

Accidental oil spills could seriously affect bowhead whales in the Chukchi and Beaufort Seas. If bowheads were to come into contact with spilled oil, they could experience a variety of effects, including pulminary stress from inhaling hydrocarbon vapors, a loss of prey organisms, ingesting spilled oil or oil-contaminated prey, reduced feeding efficiency from baleen fouling, and skin and/or sensory-organ damage. The number of whales affected by an accidental oil spill would depend on the time of year and duration of the spill, the quantity of the spill, the density of the whale population in the vicinity of the spill, and individual whale's ability to avoid the spill. One platform spill and one pipeline spill are assumed for the Beaufort Sea over a 35-year period, and one platform and two pipeline spills are assumed for the Chukchi Sea over a 40-year period (Table 4-1e).

Ice may function to restrict the spread of oil. Newly formed ice, along with spilled oil, could be blown downwind and accumulate along the downwind edge of open leads or ice floes, where they may contact bowheads along their spring or fall migration. As leads close or ice floes are blown together, oil can be pushed up onto adjacent ice. Oil spilled under the ice should pool and freeze to the underside of the ice. This fast freezing would restrict the independent movement of the oil. However, the oil would then travel as part of the pack ice or be released during the spring and summer from the fast ice. It would then either melt out on the leading edges of the ice in the spring, or pool on top of the ice as spring melting begins. Whales trapped in leads contaminated with oil during spring migration could die or experience pulmonary distress from inhalation of toxic vapors. However, bowheads are well adapted to traveling under the ice (George et al., 1989) and could possibly avoid contaminated areas.

Migrating bowheads would be in the most danger of contacting spilled oil while passing through the Beaufort and Chukchi Seas. Once migrating bowheads pass Point Barrow, they tend to disperse. Fewer individuals would be likely to contact spilled oil at any given time after moving through this region. Bowhead calving peaks during late winter and early spring. Therefore, bowheads are even more susceptible to oil contamination during the spring migration, when many young whales are present. Individuals may be killed or injured if they were to contact freshly spilled oil. The NMFS stated their belief in the May 2001 biological opinion for leasing and exploration activities in the Beaufort Sea that whales contacting freshly spilled oil could be harmed and possibly killed. Additionally, they indicated that an oil spill reaching into the spring lead system has the potential to impact a significant number of whales under certain coincidental events: (1) the spill would have to occur, (2) the spill would have to coincide with the seasonal migration, (3) the spill would have to be transported to the area occupied by whales, and (4) cleanup or response efforts would have to be at least partially unsuccessful. They also noted that the statistical probability for the coincidental occurrence of these events would be low. Unless there are multiple spills in a single year, only a few fatalities are expected to occur. However, only one large platform spill and pipeline spill are assumed likely to occur in the Beaufort Sea, and one large platform spill and two large pipeline spills are assumed to occur in the Chukchi Sea over a 35- to 40-year period.

Albert (2000) discusses the North Slope Borough (NSB) perspective on the potential effects of oil and oil spills on bowhead whales. Inupiat of the NSB have expressed concern that the effect of an oil spill on bowhead whales, whether it be into a lead or from ice as it melts and goes into a lead, could be major because of the potential for the majority, if not the whole population, to be exposed to that oil spill (M. Philo in USDOI, MMS, 1986:14). Brower (1978), quoted above in Section 3.2.3.5.1, noted how oil spilled in 1944 from a "Liberty" ship had an immediate adverse effect on sea mammals and birds, and caused whales to migrate further out to sea for 4 years afterwards. There appears to be general agreement among Inupiat people testifying at public hearings that an oil spill would have severe consequences to the bowhead whale population because effective cleanup methods of oil spilled in ice-covered waters have not yet been developed and proven.

Other baleen whales are expected to experience the same effects as a bowhead whale from accidental oils spills. Because fin and humpback whales remain relatively far offshore from OCS activities, it is improbable that many whales would be affected by an oil spill. However, if they were to come into contact with a spill, it could potentially result in the death of individuals. Additional consequences would be similar to the effects outlined for bowhead whales. The humpback whales were not severely affected by the *Exxon Valdez* oil spill (Loughlin et al., 1996). Gray whales do not concentrate like bowheads during their migration. Therefore, the impact on the population as a whole should be less than for bowheads. In addition, since gray whales migrate close to shore in southeast Alaska, accidental oil spills in the subarctic planning areas could affect feeding of migrating gray whales. Because minke whales are widely distributed throughout Alaskan waters, it is likely that an oil spill will affect some individuals. However, because they are not concentrated in specific areas, the magnitude of effect on the population as a whole should be negligible.

If sperm whales were to contact oil, they could also experience inhalation of hydrocarbon vapors, a loss of prey organisms, ingestion of spilled oil, and skin and/or sensory-organ damage. Prey contamination from a surface oil spill is unlikely since sperm whales feed primarily on deep pelagic squids and fishes. Since their movements are not restricted by ice in their spring and summer feeding grounds, sperm whales would most likely respond by avoiding a contaminated area. Avoidance may cause decreased food intake, if the spill were to occur in an especially rich feeding ground. However, direct contact with oil would be expected to be brief.

In the Beaufort and Chukchi Seas, belugas would be most vulnerable to oil contamination during spring migration (April-June) through open leads. If an oil spill were to happen within the lead system, several thousand whales could be exposed to some oil. However, unless these whales were trapped in a lead, exposure to the oil should be brief. Short or intermittent contact with oil would probably not result in any deaths of healthy whales, nor would permanent effects be realized. However, some fatalities may occur, especially to young or weak animals exposed to oil for several days. Cook Inlet belugas may be particularly vulnerable to an environmental stress because of their recent severe population decline. Potential losses due to an oil spill could aggravate population recovery. Accidental oil spills could be fatal to individuals through direct contact or reduction in prey. Only one large pipeline spill is assumed likely to occur in Cook Inlet over the 25-year period of the proposed action. Displacement caused by an oil spill and cleanup could prevent access to critical habitat areas where they feed.

Accidental oil spills are most dangerous to killer whales through ingestion of contaminated prey (Geraci, 1990; Würsig, 1990). Bioaccumulation of toxins could lead to fatalities; however, if fatalities were to occur, they are expected to be few and have a negligible effect at the population level. Killer whale pods actively used oil contaminated areas the year following the *Exxon Valdez* oil spill (Matkin et al., 1994). Because killer whales do not appear to avoid oiled areas, their risk of contamination is high. In addition, a higher mortality rate was observed in resident killer whales in Prince William Sound following the *Exxon Valdez* oil spill (Matkin et al., 1994). However, the increased mortality could not be directly attributed to that spill. In the 2 years following the spill, 13 of the 36 whales in the AB pod died. While the overall size of the Gulf of Alaska population has increased since the spill, the AB pod has increased by two, and it is expected to take many years for natural reproduction to make up for the losses (EVOS Trustee Council, 2001).

In general, harbor and Dall's porpoises are both wide ranging and could avoid areas contaminated by oil. However, harbor porpoises inhabit more inshore areas and thus may be more affected by oil spills than Dall's porpoises. An oil spill would most likely displace individuals from the contaminated area for several months. A few individuals may experience moderately adverse effects from contact with oil.

Conclusion:
Impacts to cetaceans from the proposed action range from negligible to moderate depending on the species. Should noise force an alteration of migratory pathways, it would produce **minor** impacts to bowhead whale populations. Overall, noise from OCS operations could have **minor** effects on individual bowhead whales. Routine operations, in particular noise, are expected to have only **negligible** to **minor** impacts, typically local avoidance behavior, on fin, humpback, blue, sei, and

northern right whales due to their low density and sparse distribution throughout the Alaska OCS planning areas. Potential impacts on sperm whales and minke whales due to routine operations are expected to be **negligible**. Since the population of Cook Inlet beluga whales is at a low level and in decline, disturbances, which could reduce fitness, could have **minor** to **moderate** impacts on the population, depending on the number of whales affected. Potential impacts on the remainder of the Alaska beluga population and gray whales caused by noise disturbance from routine operations are expected to be **negligible** to **minor**. Potential impacts on killer whales, and harbor and Dall's porpoises are expected to be **negligible**.

With the exception of the Cook Inlet beluga whale (which could possibly face up to **major** impacts) the impacts to cetaceans from oil spills range from **negligible** to **moderate**, depending on the species. Impacts to bowhead whales would range from **minor** to **moderate**. Most impacted individuals would experience temporary, non-lethal effects. Should several individuals be killed as a result, the population would recover in a few to several years. Overall, potential impacts on fin, humpback, blue, sei, or northern right whales due to spills are expected to range from **negligible** to **moderate**, depending on the number of whales contacted by a spill and the number of spills. Potential impacts on sperm whales due to oil spills are expected to be **negligible** to **minor**, depending on the size of the spill and the number of whales contacted. Potential impacts due to oil spills are expected to be **negligible** to **minor** for beluga whales in the Beaufort and Chukchi Seas. In general, oil-spill impacts to the Cook Inlet beluga population are expected to be **minor**, but a possibility for **moderate** to **major** impacts exists, given the current decline in the population. Potential impacts on gray whales and killer whales due to oil spills are expected to be **minor** to **moderate**. Potential impacts on harbor porpoise and Dall's porpoise are expected to be **negligible** at the population level. Any gas condensate spill in the Norton Basin is expected to have a **negligible** impact on whales.

4.3.3.3.2. Pinnipeds

Routine Operations

The Steller sea lion (*Eumetopias jubatus*) is the only listed pinniped species in this region. Rookeries and haul-outs, as well as the surrounding aquatic zones, are designated as "critical habitat" for Steller sea lions (Figure 3-27). Vessel and aircraft traffic are the industrial activities that would most likely disturb Steller sea lions. However, these activities could avoid critical habitat areas and thus would have negligible effects. Vessel activity at shore may affect some individuals that are hauled out, but these effects are expected to be short term and temporary. No construction activities will be conducted in critical habitat areas.

Routine support activities in the Chukchi Sea (1-4 vessel trips per week and 10-40 helicopter trips per week) have the greatest potential to disturb the walrus (*Odobenus rosmarus divergens*) during the open-water season. Aircraft overflights and vessel traffic may disturb walruses in the water and hauled out on ice. During twin otter aircraft surveys at approximately 305 m altitude in the Chukchi Sea, walruses in open water reacted by creating a noticeable splash when diving, and about 38 percent of those on land fled into the water. While unlikely, pups may be trampled when aircraft pass near pup groups on ice flows. However, since walruses are widely dispersed during the spring and summer, it is unlikely that a detectable population effect would occur. Fay et al. (1984) also observed walruses diving into the water from pack ice when approached by a helicopter within 400-600 m upwind and 1,000-1,800 m downwind. In Norton Basin, the low level of helicopter and vessel traffic (perhaps half that of Cook Inlet) could temporarily displace walruses; however, that displacement is expected to have a negligible impact.

Routine aircraft activity could also affect ringed (*Phoca hispida*), bearded (*Erignathus barbatus*), spotted (*Phoca largha*), and ribbon (*Phoca fasciata*) seals in the Beaufort and Chukchi Seas. Helicopter traffic to and from offshore facilities could displace seals from ice floes. Spotted seals are particularly sensitive to aircraft overflights. They respond by moving quickly across floes and diving into the water (Cowles et al., 1981). Erratic diving behavior could lead to mother-pup separation and increased pup mortality. However, spotted seals are associated mainly with the pack ice in the Beaufort and Chukchi Seas and north of most OCS activities. Ringed and bearded seals have also been known to dive into the water when approached by low-flying aircraft (Burns and Harbo, 1972; Burns and Frost, 1979; Alliston, 1981; Born et al., 1999; Moulton et al., 2000). However, some individuals show no apparent reaction to aircraft. Ringed seals would be the most affected species, since they are found closer to shore in the landfast ice during the winter months and, therefore, in areas disturbed by aircraft and on ice activities. Ribbon seals are expected to have localized, short-term reactions to aircraft, similar to bearded or ringed seals. Similarly, the low level of vessel and helicopter activity in Norton Basin is expected to result in temporary displacement of individuals and have a negligible effect on seals.

Walruses hauled out on ice have varying reactions to passing vessels, depending on ship speed and distance. These reactions include waking up, head-raises, and entering the water. Females with young generally react more to disturbances than do males. Walruses in water show very little response to vessels, until the ship is virtually on top of them (Fay et al., 1984). Walruses tend to react to icebreaking at farther distances (> 2 km) than they do to ordinary ship traffic (Fay et al., 1984). Females and young typically entered the water at distances of 0.5 to 1 km, and males entered the water at 0.1 to 0.3 km. In contrast, some walruses climbed onto the ice when an icebreaker traveled toward them. Aerial surveys have indicated that walruses on ice floes may avoid icebreaking areas within about 10 to 15 km (Brueggeman et al., 1990b). Overall, icebreaking is expected to temporarily displace walruses from the immediate area.

Icebreaking and drill ship operations have the potential to affect all ice seals. Ringed and bearded seals in the Chukchi and Beaufort Seas would be most affected, since they are common in the areas where drill operations would take place. Icebreaking is expected to locally displace individual seals and cause short-term behavioral reactions, including diving into the water at distances within 0.93 km (Richardson et al., 1995a). Migrating seals may be temporarily deflected by icebreaking and drillship activities. Icebreaking in dense landfast ice produces more noise at variable levels, while icebreakers in open water operate similar to other ships and therefore cause fewer disturbances. Ringed seals are the only ice seal that regularly occupy landfast ice. In landfast ice, ringed seal movements are restricted by location of breathing holes in the ice. Therefore, avoiding icebreakers may be difficult, if not impossible. However, it is likely that ringed seals will utilize the open water and newly refrozen areas created by icebreakers. Ringed seals will be affected by routine on-ice activities such as ice road construction and vehicle use of the roads. Moulton et al. (2000) found that ringed seal density in areas of on-ice industrial activities were generally lower in years with intensive activity such as construction, drilling, and vibroseis.

Construction activities (pipeline and platform installation) in Norton Basin could temporarily displace some marine mammals, but this displacement is expected to have a negligible impact on marine mammals.

It is likely that dredging will affect walruses by causing temporary short-term behavioral changes. Walruses are primarily benthic feeders, and dredging adversely impacts the benthic community; therefore, dredging may cause a decrease in prey availability for walrus. However, the estimated area impacted by dredging is a small portion of the available benthic habitat.

Seismic exploration is not expected to affect walruses in the Beaufort Sea because seismic operations are conducted during the open-water season in areas relatively free of ice. At this time of year, walruses may be well north of any seismic operations.

Noises produced by seismic operations can affect the hearing and locally displace ice seals. With the exception of ringed seals, most ice seals remain with the pack ice far north of where seismic exploration would take place. Individual ringed seals may be locally displaced by seismic activities. Seismic air gun blasts greater than 190 dB re 1 μPa can damage seal hearing. However, some individuals do approach operating seismic vessels well within the safety radii; this results in the temporary shutdown of seismic operations. Such mitigation efforts help reduce the possibility of seals being subjected to such noise levels during seismic exploration (Moulton and Lawson, 2000). Impacts to these seal species from seismic operations are expected to be minor.

Northern fur seals (*Callorhinus ursinus*) are rare and seasonal within Cook Inlet. Therefore, it is unlikely that many routine operations would affect the population. Routine aircraft activity (5 to 25 helicopter flights per week are assumed for the proposed action) in Cook Inlet is expected to be the greatest source of disturbance to fur seals. Aircraft traffic could temporarily displace fur seals from haulout areas.

Accidents

Any oil spill in Cook Inlet (4,600 bbl pipeline spill) or the Gulf of Alaska (7,800 bbl tanker spill) may contact one or more areas where sea lions are concentrated. Oil would affect sea lions if it were to directly contact individuals, rookeries, haulouts, or major prey species. In addition, vessel and human activity associated with cleanup efforts may cause sea lions to abandon coastal haulout areas and/or rookeries for an extended period of time. The Whiskers database contains many comments from local Natives to the effect that Steller sea lions (and other marine mammals) were adversely affected by the *Exxon Valdez* oil spill, and would be affected by any future oil spills: "He felt that the change [decline] in harvest was related to the oil spill and commented, 'I don't know if there's something in the water.' The seals took off and the sea lions disappeared, too" CODE082-040294 (Alaska Department of Fish and Game [ADFG], 1998).

Oil spills could have the most serious impact on Steller sea lions during late spring, summer, and early fall, when they are concentrated at rookeries. At these times, any spill and/or cleanup operation has the potential to disturb hundreds of sea lions. If a rookery were to be contaminated with oil, the current rate of population decline could accelerate significantly (Calkins et al., 1994). However, note also that Calkins et al. (1994) did not find conclusive evidence of an effect (accumulation of toxic hydrocarbons) of the *Exxon Valdez* oil spill on the Steller sea lion population or on individual sea lions examined. Loughlin et al. (1996) reviewed studies to determine the injury caused by the *Exxon Valdez* oil spill to marine mammals. They reported on animals found dead in spill and control areas whose tissues were analyzed for hydrocarbon levels. Sea otters, sea lions, and harbor seals had elevated hydrocarbon levels, but only sea otters and harbor seals showed population declines associated with the spill.

Cleanup operations, including helicopter overflights and vessel traffic, could also potentially increase pup mortality if operations were to occur near rookeries. Steller sea lions are very easily disturbed while on their rookeries, and adults may stampede into the water, trampling pups. Any increased mortality in the sea lion population could impact the population as a whole, given the current severe state of decline.

Direct contact with oil would affect sensitive tissue areas of adult sea lions, causing irritation to eyes, nasal passages, and lungs. Contamination of pups could have more long-term effects. A decline in prey species due to oil contamination could increase sea lion mortality. This effect would probably be more long term on the population as a whole than would direct contact with a spill itself. While there is no conclusive evidence of past oil spills causing a decline in prey species sufficient to result in a decline in any marine mammal population, we cannot rule out the possibility of such an effect occurring. Overall, with the current population declines in Alaskan waters, an oil spill contacting sea lions could potentially impact the population, depending on the size, location, and timing of the spill.

Accidental oil spills may contact and impact walruses by inhalation of hydrocarbon vapors, a loss of prey organisms, ingestion of spilled oil or oil-contaminated prey, contamination of rookeries or haulouts, and skin and/or sensory-organ damage.

Adult walruses would be less affected than young walruses by contact with oil. Adults have thick skin that would protect them from absorption of oil; however, sensitive tissues such as eyes and lungs may become temporarily irritated and/or permanently damaged. Inhalation of hydrocarbon vapors may damage or irritate lung tissue. These injuries may affect already stressed adults and could lead to some fatalities. Young walruses have more sensitive tissue than adults and may become stressed more easily. Newborn pups are more susceptible to the stress and toxic effects of spilled oil and would likely have a higher mortality rate. Walruses migrating through the Chukchi and Beaufort Seas would be most affected by oil spills (4,600-bbl pipeline spill or a 1,500-bbl platform spill). During migration, walruses are concentrated into herds. Female and pup herds that contact spilled oil could experience increased pup mortality. Since walruses reproduce more slowly than other pinnipeds, recovery would take longer than for other seals.

Accidental oil spills could detrimentally affect ice seals, haulouts, or major prey species. Spills or cleanup activities could potentially occur in areas of seal concentrations and could cause temporary displacement.

Adult ice seals (i.e., ringed, bearded, spotted, and ribbon seals) have a thick fat layer, which would help protect them from injury from oil contact. However, sensitive tissue areas, such as eyes, noses, mouths, and lungs, could be temporarily or permanently damaged, depending on the duration and extent of contamination. Fatalities could occur, but in general, only moderate sublethal effects are expected. Pups are more susceptible to oil contamination. Unlike adults, ice seal pups do not have a thick fat layer. They are insulated with dense underfur until they are several weeks old. This insulating fur could be easily fouled by oil, which could cause hypothermia in newborn pups, increasing pup mortality. Because ice seals do not congregate in rookeries, oil contamination should not affect large numbers of seals.

Ringed seals, in particular, would be most susceptible to an oil spill during the winter and spring, when the landfast ice restricts their movements. Therefore, they would be less able to disperse from an oil-contaminated area. In addition, a reduction in prey species due to oil contamination during this time period could reduce survivorship of individuals.

Migrating seals may be subjected to oil spills along their migratory paths. However, since ice seals remain relatively dispersed, any one spill should not affect a great number of seals at once.

Ringed seals and walrus occurring in Norton Basin are the primary mammals at risk from a potential gas condensate spill associated with the proposed action. Only individual seals or walrus that happen to be near the spill site would be exposed to the condensate and could experience adverse effects from inhaling toxic hydrocarbon vapors. The number of animals affected is expected to be very low and have negligible effects on marine mammals.

Accidental oil spills pose the greatest threat to northern fur seals in Alaskan waters. Due to their highly migratory nature, individual fur seals could potentially be exposed to a tanker spill in the Gulf of Alaska and a pipeline spill in the Cook Inlet. Fur seals could be affected by oil spills primarily by fouling of fur by oil, through inhalation of hydrocarbon vapors, ingestion of oil or contaminated prey, and secondary contact with oil at haulouts. Oil spills or cleanup activities could displace seals from the immediate vicinity for several months.

Fur seals rely on their thick fur for insulation, unlike many other pinnipeds, which are insulated with a thick fat layer. Oiling of their fur can result in hypothermia and death. Females returning from foraging at sea could also contaminate pups with oil. Due to the migratory nature of fur seals, it is possible for individuals to contact more than one oil contaminated area. Therefore, impacts on fur seals are expected to range from minor to moderate, depending on the number of spills, the size of the spill, as well as the number of fur seals contaminated.

Oil spills could affect harbor seals directly by causing toxic stress and displacement, and indirectly by altering forage availability. Cleanup activities may also physically disturb and displace harbor seals. Studies following the 1989 *Exxon Valdez* oil spill showed a significant decline in abundance of harbor seals at oiled sites in Prince William Sound soon after the spill, and at least 302 seals were missing at that time (Frost et al., 1994b). Elevated concentrations of hydrocarbons and other oil traces were found in tissue samples and bile of harbor seals found dead or collected from oiled areas in 1989 (Frost et al., 1994a). One year later, they found no elevated levels of hydrocarbons in harbor seal tissue taken from Prince William Sound, but oil traces were still present in bile samples. Likewise, Spraker et al. (1994) collected tissue samples from 27 seals in both oiled and nonoiled areas in 1989. Conjunctivitis, skin irritation, and liver and brain lesions were more common in oiled seals. Spraker et al. (1994) hypothesized that the damage was reversible in most cases. Nineteen seals found dead in the Sound or at rehabilitation centers also were examined. Thirteen of the 19 seals were pups and probably died due to oil toxicity or stress-related effects, while two adults were killed by blunt trauma, possibly during cleanup activities. These impacts are mitigated by maintaining proper operating procedures and oil-spill contingency plans.

Conclusion: Impacts to pinnipeds from routine operations under the proposed action are expected to be either **negligible** or **minor**, depending on the species affected. Potential impacts on the Steller sea lion due to routine operations are expected to be **negligible**, since most routine operations would not occur in critical habitat areas, where sea lions are most susceptible to disturbance. Potential impacts on Pacific walruses, ringed seal, bearded seal, spotted seal, ribbon seal, and harbor seal due to routine operations are expected to be **minor**. Potential impacts on northern fur seal are expected to be **negligible**.

Potential impacts to pinnipeds by accidental oil spills range from **minor** to **major**, depending on the species affected. Potential impacts on the Steller sea lion could range from **moderate to major**, depending on the time of year, location and size of the spill, as well as the number of spills per season. However, due to declining population number, effects of accidental spills could be **major**, if numerous or large rookeries were contaminated, resulting in high pup and adult mortality. Potential impacts on Pacific walrus and fur seals are expected to be **minor to moderate**. Overall, oil spills within the Beaufort and Chukchi Seas would have potentially **minor to moderate** population effects on ringed, bearded, spotted, and ribbon seals. Oil spills could have **minor to moderate** impacts on local populations of harbor seals. Pups are more susceptible to the toxic effects of oil and stress.

Proper mitigation should reduce impacts to the population. Any gas condensate spill in the Norton Basin would have a **negligible** impact on pinnipeds.

4.3.3.3.3. Fissipeds

Routine Operations

Impacts to polar bears (*Ursus martimus*) in the Chukchi and Beaufort Seas would most likely result from noise produced by routine industrial activities. Vessel, on-ice vehicle, and aircraft activities have been known to affect polar bear behavior. Polar bears typically flee from low flying aircraft (< 200 m in altitude and < 400 m in lateral distance; Shideler, 1993). Helicopter overflights do not appear to disturb females in dens (Amstrup, 1993). Vessel activity is not expected to greatly impact polar bears in the Alaska OCS Planning Areas. Reactions to vessels include running, walking, or swimming away. However, these reactions are brief and local. Some bears show no apparent reaction at all (Brueggeman et al., 1991; Rowlett et al., 1993). On-ice vehicle traffic and ice road construction may have up to moderate effects on denning polar bears; however, mitigation should reduce the level of disturbance. Polar bears occasionally emerge from their den when on-ice vehicle traffic passes within a few hundred meters. Some of these dens may be abandoned, which could reduce cub survival (Amstrup, 1993). Amstrup (1993) also reported that most maternal denning polar bears (10 of 12) tolerated exposure to high levels of human activity.

Polar bears are curious by nature. They often approach stationary manmade structures. They have been known to approach stationary drillships and drill sites on platforms and artificial islands (Stirling, 1988).

It is unlikely that polar bears are affected by seismic noise in water. They swim with their heads above water, reducing the risk of hearing damage. In contrast, on-ice seismic work during the winter is more apt to disturb polar bears. Females with cubs have been reported to abandon den sites when a seismic crew is operating nearby (Trasky, 1976; Amstrup, 1993). Premature den abandonment could lead to an increase in cub mortality.

Local residents report that polar bear numbers are increasing, and that they will investigate strange noises (1996 Nuiqsut Whaling Captains Meeting, cited in USDOI, MMS, 1999). However, "Polar bears that den . . . will not tolerate noise disturbance" (Billy Adams, USDOI, MMS, 1986a).

Exploration, development, and transportation of coastal and offshore oil and gas resources could affect sea otters (*Enhydra lutris*) and their habitat in several ways. Noise and disturbance from ship and aircraft traffic, seismic activities, rig construction, and drilling could cause sea otters to abandon or avoid otherwise suitable habitat (USDOI, FWS, 1993). Riedman (1983) subjected sea otters in California to simulated industrial noises associated with oil and gas exploration and development and found no movements of otters out of the vicinity of the sound projection, indicating no habitat abandonment. One group, or raft, of otters displayed slightly alarmed behavior at the close approach of a seismic air gun vessel and the loud airborne sounds generated. Mating activities and mother-pup interactions were considered unaffected during all phases of the air gun experiments. Riedman (1983) concluded that the behavior, density, and distribution of sea otters in the study area were not affected by the playback of industrial noises and the sounds generated by the air guns. Sea otters appear to habituate to regular human activity, as they may be commonly viewed swimming leisurely about the docks of Valdez or from fast moving commercial glacier/wildlife viewing boats in Prince William Sound and the Gulf of Alaska.

Accidents
Accidental oil spills could potentially affect polar bears through contamination of prey or reduction of prey availability, fouling of fur, and oiling of ice. These effects could be lethal. In addition, cleanup operations could disturb polar bears and could lead to temporary abandonment of cleanup areas.

Polar bears are very sensitive to oil contact (Geraci and St. Aubin, 1980; Engelhardt, 1981; Oritsland et al., 1981). Fouling of fur greatly reduces its ability to insulate, and can result in hypothermia and death. Direct contact with oil or secondary contact with contaminated ice could be fatal. However, in most areas, polar bears occur at low densities. Therefore, small numbers of bears would be affected by a single spill. Multiple spills or spills along the ice edge where bear density is greater would increase mortality rate. Over a 35- to 40-year period, two large spills are assumed likely to occur in the Beaufort Sea Planning Area, and three Chukchi Planning Area (Table 4-1e).

Ringed seals are the primary prey of polar bears and are, therefore, directly linked to their survival. If seal density were affected by oil spills or cleanup operations, polar bears could experience increased stress and possibly lower survivorship.

Sea otters are showing recovery after the *Exxon Valdez* oil spill with the exception of the Knight Island local population in the most heavily oiled bays (Exxon Valdez Oil Spill Trustee Council, 2001). An estimated 13,000 sea otters currently populate Prince William Sound.

Conclusion: Overall, potential impacts to polar bears from routine OCS activity (including helicopter operations) under the proposed action are expected to range from **minor** to **moderate** (in the case of on ice vehicle traffic). It is expected that routine operations will have **negligible** impacts on sea otter populations.

Overall, impacts of oil spills are expected to produce **minor** impacts to polar bears and produce **moderate** impacts to sea otters.

4.3.3.4. Terrestrial Mammals

4.3.3.4.1. Caribou and Muskox

Routine Operations
Four caribou herds, the Western Arctic Herd (WAH), Central Arctic Herd (CAH), Teshekpuk Lake Herd (TLH), and Porcupine Caribou Herd (PCH), use habitat adjacent to the Beaufort and Chukchi Sea Planning Areas (Figure 3-28). In general, caribou use of these areas is restricted to the months of June, July, and August. However, a portion of the TLH remains on the coastal plain through the winter, as a portion of the WAH also overwinters in coastal habitats bordering the Chukchi Sea. Winter construction of onshore infrastructure and pipelines for the proposed action may disturb caribou overwintering near the coast. Routine operations that will directly impact caribou are the construction and maintenance of onshore pipelines and infrastructure (Table 4-1b). In particular, the construction of a pipeline for the transport of crude oil from the Chukchi Sea Planning Area to the Trans-Alaska Pipeline System (TAPS) would extend the oil pipeline across nearly the full length of the arctic coastal plain, potentially influencing the movement and distribution of caribou herds.

The primary issue surrounding oil and gas development in caribou habitat is displacement of animals from preferred calving and foraging areas (Cameron, 1983). Displacement can occur as a result of obstructions to movements, disturbances, and/or habitat change. Displacement impacts can be realized at individual and/or population levels by increased energy expenditure, use of suboptimal habitat, subsequent mortality and reduced productivity, and changes in herd composition.

Pipelines and roads can act as barriers to caribou movements depending on traffic volume and speed, dust levels, the proximity of pipelines to roads, roadside vegetation, traditional movement patterns, dynamics of herd behavior, predator avoidance, insect harassment, and the habituation of individual animals to the presence of such structures. Curatolo and Murphy (1986) concluded that heavily trafficked roads directly adjacent to pipelines tend to impede caribou movements greater than roads that were separated from pipelines by at least 100 m. This behavioral response can last minutes to days. They also confirmed that pipelines elevated greater than 1.5 m facilitate caribou crossing. Cameron et al. (1995) reported avoidance by caribou of the older Prudhoe Bay complex, which consists of higher densities of pipes built lower than 1.5 m above the ground. Pollard et al. (1996), using a much larger sample size, documented large movements of caribou through the same area. Caribou may be temporarily deflected or delayed from crossing over roads and under pipes, but they continue to use historical habitat even in the most highly concentrated areas of North Slope development and do not appear to avoid oil field infrastructure during the postcalving period (Cronin et al., 1998).

During the calving season, from late May until late June, which includes the actual calving dates and the following 2-3 weeks, cows with calves are particularly susceptible to disturbance by human activities, and some degree of localized displacement from onshore oil field infrastructure does occur (Cameron et al., 1992). Surveys have shown a shift in the majority of the CAH's western calving area from within the Milne Point and Kuparuk areas to the southwest (Lawhead and Cameron, 1988). However, suggestions that this shift was directly and solely caused by oil field operations, that the new area of highest calving concentration is nutritionally less adequate, and that this event will cause overall negative effects in the herd are conjectural and unsubstantiated quantitatively (Murphy and Lawhead, 2000). Calving areas are subject to annual variation due to many environmental factors, and have been documented in areas without industrial development in herds such as the CAH (Noel and Olson, 1999) and PCH (Clough et al., 1987).

There are a lack of data on the effects of aircraft disturbance on North Slope caribou. Visual effects are temporary and depend on variables such as environmental factors, levels of habituation, activity of the group or individual at the time of encounter, and type of aircraft. Low-flying jet aircraft and helicopters are more likely to produce negative responses from caribou than are light fixed-wing aircraft (Maier et al., 1998).

Habitat change and loss by means of displacement and fragmentation, especially during the calving season, have been prominent issues during the development of the North Slope oil fields. Direct loss of habitat to the placement of gravel pads and roads is inevitable, but is mathematically small in scale both temporally and spatially considering the area available on the coastal plain and the extent to which it is used by the caribou herds on an annual basis.

Onshore facilities and activities associated with the proposed offshore development program in northern Alaska should have temporary impacts on individual caribou but negligible effects on caribou herds. Negative impacts to caribou can continue to be minimized by mitigation measures, including:

- construction of pipelines at least 100 m from roads;
- elevation of pipelines greater than 1.5 m above the ground;
- maintenance of traffic control in critical areas such as calving grounds in season;

- installation of buried or higher than normal pipelines in areas that are typically traveled heavily by caribou; and
- adherence to minimum altitude levels for aircraft in flight.

Nannie Woods testified that caribou and fishes have been less abundant at the Sagavanirktok River since the development of Prudhoe Bay (cited in USDOI, MMS, 1979c). Residents of Nuiqsut and Kaktovik have a general consensus that caribou are not as available as close to the community as they had been in the past, due at least in part to oil and gas exploration (and in the case of Nuiqsut, development) activities (Impact Assessment, Inc., 1990a,b). Mayor Leonard Lampe of Nuiqsut related at an MMS Liberty Project Information Update Meeting in November 1999 that Nuiqsut residents do not see as many calving caribou as they have in the past. The Tarn Project well has apparently changed their south/north migration, and the Alpine Project may affect their east/west migration. Caribou now have three pipelines to cross (cited in USDOI, MMS, 2001). Kaktovik residents made similar remarks (Jonas Ningeok and Isaac Akootchook, cited in USDOI, MMS, 1979b), and Nolan Solomon added a comment on the effects of air traffic. "There used to be lots of caribou. . . . Today, you can hardly see any. I think strongly because of air traffic. Small planes and helicopters fly 50 feet above the coast . . . driving our caribou away from calving areas and migrating patterns and also cause caribou to leave their young" (USDOI, MMS, 1979b).

Muskox are generally similar to caribou in their response to potential disturbance from OCS exploration and production activities. Muskox are present in the arctic region through the winter, making disturbance from winter construction more likely. However, the limited distribution and smaller population size of muskox compared to caribou should greatly restrict impacts.

Overall, impacts to caribou and muskox inhabiting the arctic coastal plain will generally be minor if standard mitigation measures described above are followed. Some displacement of caribou from development areas, roads, and pipelines will probably occur, particularly during the calving season, but no long-term impacts are expected.

Accidents

Oil spills assumed for the Beaufort Sea and Chukchi Sea/Hope Basin Planning Areas are presented in Table 4-1e. There are no data to suggest that oil or fuel spills from onshore and offshore activities have caused mortality of any caribou or muskox on the North Slope. In the event of an onshore oil spill that contaminates tundra habitat, these animals probably will not ingest oiled vegetation because they are selective grazers. Oil-spill cleanup activities will tend to displace these animals from contaminated habitats. If animals were directly oiled, they could die from the inhalation of toxic hydrocarbons and/or absorption of oil through the skin (USDOI, MMS, 1996a). Staging and support activities for a large offshore spill cleanup could temporarily displace animals. If an oil spill were to occur from the proposed action, the expected overall impacts on caribou and muskox from accidental spills from the proposed action would be minor.

4.3.3.4.2. Arctic Fox

Routine Operations

Arctic foxes are distributed throughout the arctic region of Alaska, utilizing the coastal and offshore habitat in both the Beaufort and Chukchi Sea Planning Areas. Arctic fox populations are generally cyclic in nature (having an average periodicity of 3-4 years) and fluctuate with the changes in local rodent populations (Chesemore, 1968; Macpherson, 1969; Speller, 1972). They are one of the most abundant and opportunistic predators in the arctic.

Offshore oil and gas developments and their corresponding onshore facilities (Table 4-1b) can exert numerous impacts on the ecology and behavior of arctic foxes. Arctic foxes can become habituated or attracted to human activities related to petroleum development (Urquhart, 1973; Fine, 1980; Eberhardt et al., 1982; Rodrigues et al., 1994). This attraction to human activities stems from the increased availability of anthropogenic food sources, such as garbage, litter, and handouts (Eberhardt et al., 1982). Anthropogenic food sources can lead to numerous behavioral and physiological changes in the arctic fox populations surrounding developed areas. Dispersal can be hindered with anthropogenic food sources. Foxes typically disperse from their summer ranges in late fall and early winter when natural prey becomes scarce (Chesmore, 1968). However, in one radiotelemetry study, arctic foxes inhabiting the developed Prudhoe Bay area did not disperse during the winter, suggesting that some factor, possibly winter food availability, had discouraged dispersal (E. Follman, oral commun., 2000). Anthropogenic food sources may also increase survival of young and adults foxes (Bannikov, 1970). Arctic fox densities were higher in developed areas than in adjoining undeveloped regions (Burgess and Banyas, 1993; Perham, 2000). Increased fox densities caused by human activity increases predation on local natural prey species, such as tundra-nesting shorebirds and waterfowl (Johnson et al., 1993a,b). Increased fox predation on waterfowl could possibly impact federally listed threatened species (e.g., spectacled and Steller's eiders). Finally, of great concern with increased fox densities near human development is the transmission of diseases such as rabies, canine distemper, and canine hepatitis. Arctic foxes are a major transmitter of the rabies virus in the arctic (Dieterich and Ritter, 1982; Ritter and Follmann, 1995; Robards et al., 1996), and transmission can occur more readily in areas of high fox concentrations (Ritter and Follmann, 1995).

Additionally, arctic foxes could be impacted by oil and gas development with the loss of natural denning habitat or creation of artificial denning habitat at onshore facilities. Den distribution and abundance depend on suitable landform availability. Arctic foxes reuse dens, constantly excavating them. In some instances, active dens can be 200-300 years old (Macpherson, 1969). Placement of onshore development facilities (e.g., roads, pipelines, runways, structures, etc.) could eliminate local den sites. Conversely, arctic foxes may also use onshore facilities as den sites. Burgess and Banyas (1993) documented arctic foxes using manmade structures (e.g., culverts, utilidors, crawlspaces) for den sites in the Prudhoe Bay oil field. Foxes have also created den sites near old exploration pads (Perham, 2000).

The greatest impact to arctic foxes by offshore facilities would occur during the ice-covered season. Foxes are highly mobile, and disperse out onto the sea ice in search of food during late fall and winter. Due to this mobility, foxes visit offshore facilities (e.g., drilling platforms, ice roads, exploratory seismic trains) during winter months in search of food. Arctic foxes were regularly observed near Seal Island in the Northstar development during the 1999/2000 ice-covered season (C. Perham, oral commun., 2000). During the ice-covered season, foxes routinely traverse the barrier islands. During spring months, they have been suspected of contributing to nesting failure of barrier island nesting birds, such as Pacific eiders (Noel et al., 1999).

Mitigation measures designed to reduce impacts on arctic foxes inhabiting the North Slope oil fields include improved waste management procedures such as eliminating access to landfills, placement of animal-proof garbage dumpsters, and educating oil field personnel on the danger of human/fox contact. Overall, localized oil development and routine operations under the proposed action should have minor impacts on resident arctic fox populations throughout the Beaufort Sea and Chukchi Sea/Hope Basin Planning Areas.

Accidents

Accidental oil spills (Table 4-1e) could potentially affect arctic foxes through contamination of prey or reduction of prey availability, and through fouling of fur causing loss of its insulating capacity. Although arctic foxes are abundant predators on the North Slope, their mobility allows them to disperse from oiled areas, if necessary. Conversely, as opportunistic carnivores, arctic foxes may prey on oiled birds and consume oiled carcasses. Some loss of arctic foxes may result from oiling but these are likely to be replaced by normal reproduction within about a year. It is thus expected that if an oil spill were to occur and contact land, the impacts on arctic fox populations would be minor.

4.3.3.4.3. Grizzly and Black Bears

Routine Operations

Grizzly (brown) bears utilize the coastal environments and/or terrestrial oil transportation routes onshore of all Alaska Planning Areas, and black bears make extensive use of coastal areas in Cook Inlet and the Gulf of Alaska. Table 4-1b presents the exploration and development scenarios for the proposed action. Aircraft traffic may disturb individual bears occasionally for a short period of time but is unlikely to disrupt denning bears. Onshore infrastructure placement could disrupt individual bear dens located near the coast. However, most bears den further inland. Bears may become habituated or attracted to human activities, often leading to conflicts with people (Follman and Hechtel, 1990). Use of anthropogenic waste by bears in the oil fields became a problem by the late 1980's (Shideler and Hechtel, 1991). Shideler and Hechtel (2000) report that 21 percent of grizzly inhabiting the North Slope oil fields supplemented their diets with anthropogenic food sources from dumpsters, camp storage areas, and the NSB landfill at Prudhoe Bay. Their earlier study found that cubs with food-conditioned sows have a much lower mortality rate (5.6 percent) than those with sows that do not use anthropogenic food sources (52 percent). However, once independent of their mothers, these food-conditioned bears have a significantly higher mortality rate than that of independent offspring of females that fed solely on natural foods.

Mitigation measures designed to reduce impacts on bears in North Slope oil fields include prohibiting firearms and hunting within the developed area, educating oil field personnel about bear safety, training security personnel in proper hazing techniques, eliminating access to the landfill by bears, and installing bear-proof lids on all dumpsters. With such measures in place, impacts of routine operations on grizzly and black bears would be minor.

The State of Alaska has stated (State of Alaska, written commun., 2002) that there are seasonal concentrations of bears along the west side of Cook Inlet and on the Kenai Peninsula. Large numbers of bears congregate in the spring along the coast to feed on emerging sedges, clams and marine mammal carcasses. The bears may also concentrate along salmon streams during late summer and fall to feed on returning fish. Peninsula brown bears, considered an isolated population, have been designated as a Species of Special Concern by the ADFG. Given the limited onshore infrastructure of the proposed action in Cook Inlet (Table 4-1b), indicating no new shore bases, processing facilities, or waste facilities and only temporary disturbance due to construction of pipelines and associated landfalls, the impacts on these bears from routine operations are estimated to be minor.

Accidents

Accidental oil spills assumed for the proposed action scenario are presented in Table 4-1e. Lewis et al. (1991) examined the impacts of the 1989 *Exxon Valdez* oil spill on Katmai National Park coastal brown bears. Of 27 bears captured, 4 had been exposed to crude oil. Bears were also observed with oil on their fur, consuming oiled carcasses, and presumably feeding on razor clams in the intertidal area. One yearling bear was found dead with high concentrations of aromatic hydrocarbons in its bile. Crude oil elements were also found in the fecal samples of the bear's mother. However, no population-level impacts on the bears of Katmai were indicated.

Contamination of coastal streams, beaches, mudflats, or river mouths from oil spills (e.g., a tanker spill in the Gulf of Alaska or a pipeline spill in the Beaufort Sea: Table 4-1e) may result in food and fur contamination of grizzly or black bears. This would likely result in sublethal effects of some bears and might contribute to a decline in survival of exposed bears. This may result in minor impacts at the population level. In the Cook Inlet area, given the potential seasonal concentrations of bears along the coast (State of Alaska, written commun., 2002), the impact resulting from a larger oil spill may be moderate.

4.3.3.4.4. River Otter

Routine Operations

River otters can be found using intertidal and subtidal habitats adjacent to the Cook Inlet and the Gulf of Alaska Planning Areas. River otters are highly adaptable and able to shape their individual and social existences around environmental variables, and are able to coexist with human presence and activities (Home, 1984). Table 4-1b presents the exploration and development scenarios for the proposed action. Boat traffic may disturb individual otters for a brief period of time. Overall, routine operations from the proposed action would have negligible impacts on river otter populations.

Accidents

Accidental oil spills in the Cook Inlet and Gulf of Alaska Planning Areas from the proposed action are presented in Table 4-1e. Results of biological studies of the consequences of the *Exxon Valdez* oil spill in 1989 provide the majority of data regarding direct impacts of large-scale oil-spills on river otters. Faro and Calk (1992) suggest that river otters are good terrestrial mammal indicators of oil spill impacts since their position in the food web means their health would reflect general ecosystem conditions. Faro et al. (1994a) concluded that, in addition to an undocumented number of direct mortalities, population-level impacts occurred in oil-exposed otters due to sublethal physiological effects, including higher heptaglobin levels in the blood, compromised immune systems, and lower body mass. Behavioral and ecological impacts included loss of preferred habitat, changes in food habits, abandonment of latrines, and utilization of larger home ranges. However, otters did not completely abandon any area of the spill. Nowlin (1998) also suggests that (river) otters may have suffered population level impacts in the spill area. Faro et al. (1994b) found that by 1992, oiled river otters no longer exhibited oil traces in their blood and, when compared to non-oiled otters, their body masses were nearly identical.

River otters inhabit coastal habitats of the Cook Inlet and Gulf of Alaska Planning Areas that may be exposed to oil. Oil contamination of these habitats could contaminate locally important food sources and expose the furbearer to direct oiling and oil ingestion through grooming and consumption of contaminated prey and oiled carrion. Potential impacts on the Alaskan river otter are likely to be minor to moderate.

4.3.3.4.5. Sitka Black-Tailed Deer

Routine Operations

Sitka black-tailed deer occur primarily on the islands and mainland along Prince William Sound, the Kodiak Archipelago, and along the Yakutat Bay coast of the Gulf of Alaska Planning Area (USDOI, MMS, 1995b). Routine operations associated with OCS activities will have negligible, if any, impact son deer in the area because they are beyond the areas of OCS onshore routine activities.

Accidents

There are no studies of direct impacts of spilled oil on Sitka black-tailed deer. If oil were to reach the Yakutat coast in the Gulf of Alaska from a tanker transportation spill (Table 4-1e), intertidal vegetation may be contaminated. The combination of oil ingestion with vegetation and hydrocarbon absorption through the skin could increase the winter mortality among deer in the Yakutat area (USDOI, MMS, 1995b). This would likely result in a minor to moderate impacts on the population in the area.

The estimated probability of one or more large spills ($\geq$500 bbl) occurring from the proposed action is provided in Table 4-1e. The probability for such a large spill occurring is estimated as 16-18 percent (Cook Inlet), 81-94 percent (Beaufort Sea), and up to 98 percent (Chukchi Sea).

Conclusion: The impacts on terrestrial mammals due to routine activities from the proposed action would be **negligible** for river otter and Sitka black-tailed deer; **minor** impacts are expected for caribou, muskox, arctic fox, grizzly bear, and black bear. If a large oil spill were to occur, the impacts would be expected to be **minor** for caribou, muskox, and arctic fox; **minor** to **moderate** impacts would be expected for grizzly bear, black bear, river otter and Sitka black-tailed deer.

4.3.3.5. Marine and Coastal Birds

4.3.3.5.1. Routine Operations

Arctic

The impacts of routine operations on threatened Steller's and spectacled eiders would be similar to those described for nonlisted species discussed in detail below.

Gravel used to construct offshore islands to support drilling operations is typically mined from river bars during winter construction operations. Most bird species have left the arctic during winter, and winter gravel mining would not affect seabirds, waterfowl, or shorebirds at that time. Removal of gravel from river bars would change gravel bar habitats to open-water habitats. A few species, such as Baird's sandpiper and semipalmated plover, that use gravel bar habitats for nesting may be adversely affected during the breeding season by winter gravel mining operations. These species nest in low densities, and the significance of disturbance in terms of nesting habitat loss depends on the extent of gravel removal. Since not all gravel bars proposed as gravel sources are devoid of vegetation, other plovers, sandpipers, and turnstones potentially could be affected. New open-water habitats produced by gravel mining would not be expected to benefit bird species.

Installation of subsea pipelines (2 in the Beaufort Sea and 1 each in the Chukchi Sea and Hope Basin) to transport oil from offshore platforms or gravel islands to land-based pipelines during the production phase will require underground trenching. Presumably, trenching activities will be carried out during the winter when seabird and waterfowl species are not present, and there will be no negative impacts to birds at that time. However, trenching of the seafloor may disrupt benthic invertebrate communities that serve as food sources for waterfowl during the summer months. The extent of impacts would depend on the amount of trenching and quality of the affected area as feeding habitat.

Ice roads are used to build and access gravel island construction sites during the winter. Ice roads may be constructed over both tundra habitats and frozen ocean habitats. During construction of ice roads, water from local rivers and lakes is pumped onto the desired area to build up a rigid surface. Ice roads over frozen ocean habitats are not expected to adversely impact most bird species. However, small numbers of black guillemots overwinter in cracks and leads in the otherwise frozen Beaufort and Chukchi Seas. Winter construction of ice roads and subsequent traffic could displace these birds. Water removal from lakes may have a negative impact on summer breeding populations of tundra-nesting birds if lake levels are reduced to the extent that aquatic habitats are damaged. Eiders, loons, and other waterfowl typically nest at or near lake shores, and lakes are important as brood-rearing habitat.

Ice roads also may be constructed over terrestrial habitats to provide routes for winter transportation of supplies and equipment, and for construction of onshore pipelines. Ptarmigan, snowy owls, and gyrfalcons are winter residents that may be present in areas where ice roads are being constructed. Ravens are not historically known as winter residents on the arctic coast, but a few are able to find food where human development has occurred and may also be present in the winter in small numbers. Winter construction of ice roads and subsequent traffic could displace these birds from preferred habitats. However, the affected area would be relatively small, and expected impacts would be negligible.

Ice roads constructed over tundra habitats may cause temporary disturbance to vegetation. Tundra under ice roads may become ice free later in the season, and may not be available early enough to be used as nesting habitat. This should affect tundra-nesting species for only the first year after construction. Flattening of vegetation, which may discourage nesting of tundra bird species, may also occur under ice roads (Walker et al., 1987a). These effects may continue until vegetation has completely recovered. The amount of habitat temporarily lost due to ice road construction is relatively small, and birds may move to adjacent habitat (Troy Ecological Research Associates, 1990). The impacts of ice roads on tundra habitats would be expected to be minor.

Terrestrial pipelines constructed adjacent to ice roads may accumulate drifting snow. This may result in an annual pattern of delayed snowmelt on tundra adjacent to pipelines. The affected habitat would be confined to a small area near pipeline support structures, and negative impacts would be expected to be minor. Pipeline support structures may also provide nesting habitat for snow buntings and may be beneficial to this species.

During the 35- to 40-year period of the proposed action, 30-60 helicopter flights per week are assumed for the Beaufort Sea, 10-40 for the Chukchi Sea, and 10 for the Hope Basin Planning Areas. Helicopter overflights generally are conducted at low altitudes and can be a major source of noise affecting waterfowl. Helicopters are commonly used to transport personnel, supplies, and equipment to and from offshore platforms, gravel islands, and other remote sites, and to fly aerial surveys during routine maintenance operations. Large numbers of waterfowl use lagoon systems of the Beaufort and Chukchi Seas for fall molting and staging prior to migration (Johnson et al., 1991; Noel et al., 2000). Molting and staging waterfowl can be temporarily displaced by helicopter overflights. Responses of geese to helicopter overflights include alert behavior generally followed by flight (Ward and Stehn, 1989). A common theme at public hearings is that noise from oil and gas activities, and air and boat support activities in general (whether for industry, research, or whatever), disrupt bird populations (Impact Assessment, Inc., 1990a,b). In 1979, for example, Mike Edwards of Kaktovik expressed the view that noise harms waterfowl, which are an important source of food in the spring (USDOI, MMS, 1979b).

Long-tailed duck, eiders, and other waterfowl use coastal and lagoon habitats at different times of the day for shelter and feeding. Areas near shorelines of barrier islands and the mainland frequently are used for protection during storms. Birds also may gather at preferred feeding areas. Noise from helicopter overflights may cause displacement of waterfowl from preferred habitats to less desirable ones. If broods are scattered during helicopter overflights, young birds may become more susceptible to predation. Helicopter flights of short duration over coastal brood-rearing salt marshes or inland lakes used as brood-rearing habitat should allow scattered broods to reassemble quickly, and negative impacts should be minor.

The amount of helicopter traffic may vary during different phases of construction and/or oil production. Helicopter traffic may be particularly frequent during spring breakup and fall freeze-up when no other means of transportation is available to access platform and gravel island facilities. Aside from locations and habits of waterfowl, factors to consider when evaluating effects of helicopter noise on waterfowl are flight path, altitude, and number of overflights (Derksen et al., 1992; Jensen, 1990; Miller, 1994).

Fixed-wing aircraft also are used for oil field activities, though less frequently than helicopters. Fixed-wing aircraft are commonly used for aerial surveys of caribou and waterfowl. These aircraft generally fly higher and are in any given area for a shorter time period than helicopters, and noise impacts to birds are less. Flight patterns that avoid sensitive areas for bird feeding, nesting, molting, and brood rearing can be implemented for both fixed-wing aircraft and helicopters.

Boat and barge noise and traffic also could disturb molting waterfowl by displacing them from preferred habitats, resulting in expenditures of greater amounts of energy than would normally be used for feather replacement. The effect of disturbance would be greatest in areas where waterfowl were concentrated, and less in areas where birds occurred in scattered groups. The impact on waterfowl would be related to noise levels, the amount of boat and barge traffic, and boat speed. The proposed action calls for one to two vessel trips per week in the Beaufort Sea and two to four trips per week in the Chukchi Sea/Hope Basin.

Seismic surveys conducted from boats in offshore areas and in lagoon systems could impact waterfowl. Noise from airguns and disturbance from boat traffic could displace birds from preferred habitats. These disturbances would be limited to the immediate area around survey vessels, and negative impacts to waterfowl would be expected to be minor.

Most noise associated with construction and drilling operations on gravel islands would be expected to occur during the winter when most bird species are not found in the arctic planning areas. The occurrence of these types of noises during spring migration and the fall molting and staging periods could displace birds in the immediate area. If construction and drilling noises are continuous, birds may become acclimated to them over time; under these circumstances, impacts are expected to be minor.

Manmade structures such as drilling towers, tall buildings, and gas flares could present potential hazards to birds. The nearshore zone along the coastlines of the Beaufort and Chukchi Seas is used as a migration corridor by sea ducks, loons, geese, and shorebirds (Johnson and Herter, 1989). Gas flares could attract birds, which results in the birds getting too close. During migration and/or periods of low visibility, birds could collide with towers, buildings, equipment, or wires. The number of birds affected by manmade structures would be expected to be small and the impacts minor.

Onshore facilities such as construction camps may be established to expedite construction efforts during offshore drilling projects. Construction camps serve as a holding area for machinery and supply inventories, as a staging area for construction efforts, and as housing for oil field personnel. There may also be areas of fuel storage associated with construction camps. Housing of personnel will require special treatment for sewage and garbage. Such onshore facilities would not be usable as bird habitat and would be lost as habitat for the duration of use as a camp facility. In addition, variable local disturbance in the immediate area adjacent to the camp may result from human activity and machinery noise. At abandonment, some of the original habitat at construction camps may be reclaimed, but some may be permanently lost. Impacts are expected to be negligible.

Gulls may be attracted to manmade structures because of the potential food resources available at construction and production sites. Gulls are natural predators of bird eggs and young, but gull populations that are artificially high can cause increased predation that can have a significant negative impact on local bird populations (Johnson et al., 1993a,b; Johnson, 1994; Johnson, 2000a). Gull attraction to facilities could be reduced by properly maintaining dumpsters and by confining garbage to dumpsters with secure lids.

Ravens also can be attracted to oil field facilities because of the presence of anthropogenic food sources and elevated nesting sites on building and towers. Ravens do not normally breed in coastal areas away from foothill nesting sites. While ravens may occasionally roam from foothill breeding sites to coastal areas, they are only opportunistic predators of bird eggs and young in this area. However, breeding pairs with nest sites located on buildings and towers on oil-field facilities may become serious predators on bird eggs and young. Elimination of anthropogenic food supplies and nesting sites for ravens at oil-field facilities will reduce the negligible impacts of ravens on other bird species.

Offshore discharges from drilling operations that include drilling muds and cuttings can enter the environment. Cuttings are frequently discharged back onto the seafloor, while drilling muds are recirculated through the drill casing. Potential for drilling muds to contaminate offshore habitats also could occur during transportation of drilling muds or other drilling additives through an accident or spill. Estimated concentrations of trace metals associated with drilling muds after dilution show values below USEPA criteria levels for saltwater aquatic life. Spills of drilling muds would be expected to be localized and impact relatively small areas. Exposure impacts to marine birds and waterfowl from drilling muds would be expected to be negligible.

Many maintenance activities can be planned during times when most birds are not in the area. Routine visual inspections of pipelines and facilities during the winter on snow machines and/or four-wheelers could displace ptarmigan and snowy owls temporarily. For disturbances of short duration, birds would be expected to return to original habitats or use suitable habitats nearby. Disturbances of longer duration could displace birds on a more permanent basis. Impacts to bird populations from maintenance activities would be expected to be minor.

Maintenance activities conducted during the breeding season may negatively impact nesting birds by flushing them from their nests. Possible impacts include chilling of eggs, increased nest predation, and decreased nest success for some species. Scattering of broods could also result from maintenance activities that could cause increased predation on young birds. Short duration maintenance activities would have minimal impact on nesting birds, as birds flushed from nests would likely return shortly after the disturbance was over. Prolonged periods of maintenance activities could have a greater impact on nesting birds by increasing cooling periods of eggs, and on brood-rearing birds by increasing the time that young and adult birds are separated. The number of birds affected is not expected to be large, and impacts would be minor.

The arctic peregrine falcon (delisted in 1994) breeds in tundra regions. The American peregrine falcon (delisted by the USDOI, FWS in 1999) nests in boreal and temperate forests. Both subspecies are on the Alaska Department of Fish and Game's list of Species of Special Concern. Arctic peregrine falcons nest inland in foothill areas of the Brooks Range. During the summer, arctic peregrines range to coastal areas of the Beaufort Sea where they are an uncommon summer visitor and migrant (Johnson and Herter, 1989). Peregrine falcons have nested near pipeline construction projects and have shown the ability to successfully adapt to construction activities (Ritchie, 1987). Routine operations, related to oil exploration and production in the arctic planning areas, are expected to produce negligible impacts to both peregrine falcon species.

Subarctic

Many, but not all, of the considerations for the arctic planning areas would apply to the subarctic planning areas. In the subarctic, ice roads and gravel islands would not be constructed; thus, impacts associated with these structures would not apply. Onshore impacts such as pipelines and construction camps also would not apply, as existing facilities are already in place at Nikiski. In the lower Cook Inlet, there would be a greater emphasis on oil transport via tankers and barges than in the arctic, and impacts associated with shipping need to be considered for the subarctic planning areas.

Unlike the arctic planning areas, seabirds and/or waterfowl are present in the subarctic on a year-round basis. Impacts to bird populations from oil-field operations would not be restricted to a relatively short summer season, as is the case for the arctic.

In the subarctic planning areas, oil drilling and production are conducted from platforms constructed offshore. Placement of platforms can cause disruption of bottom sediments during installation and removal activities. As suspended sediments resettle, they may drift and cover other bottom communities containing benthic invertebrates that form part of the food chain for seabirds and waterfowl. The extent of negative impacts to seabird and waterfowl feeding habitats would depend on the quality and quantity of the benthic habitat disturbed. Above-water impacts from platform structures could be similar to those in the arctic planning areas. Migrating seabirds and waterfowl could be attracted to flares or collide with towers or wires. Such impacts would be expected to be minor.

Oil may be transported from production platforms in the lower Cook Inlet Planning Area to processing facilities by subsea and overland pipelines. Subsea pipelines installed in trenches or resting on the seafloor could impact benthic habitats by disrupting bottom sediments in the same manner as platform installation and removal activities. The benthic habitats affected by submerged pipelines could be more diverse and cover a much greater area than habitats affected by platforms because pipelines may traverse many miles. Overland pipelines that connect subsea pipelines to refining facilities would have negligible impacts on birds because the refining facilities are located on the coast, and new overland pipelines would be located on already existing facilities.

During construction activities in Norton Sound (laying 25-55 miles of pipeline and installing 1 production platform), some flocks of birds could be temporarily displaced near the pipeline route and platform site. Any disturbance and displacement of birds during construction are expected to have negligible effects on the abundance and distribution in Norton Sound.

The most prevalent noise factors likely to negatively impact bird species are those associated with aircraft. Responses to noise are variable, but may include nest abandonment. Low flying aircraft may frighten birds from nests, leaving eggs and young vulnerable to predation and exposure. Cormorants, gulls, murres, guillemots, and puffins are colonial nesters in the lower Cook Inlet that could be affected by noise from low flying aircraft. Large seabird nesting colonies in the Barren Islands are far enough from the proposed lease areas that aircraft noise should not pose a significant problem. Noise from low flying aircraft may also displace birds from feeding and staging areas. This would likely be a temporary displacement and negative impacts would be expected to be minor. Aircraft routes could be designed to avoid sensitive areas for seabirds and waterfowl. Noise and disturbance effects on birds from aircraft and vessel traffic are expected to be short term and local, having a negligible impact on bird populations in Norton Sound.

Impacts from seismic surveys conducted from boats in the subarctic region would impact marine bird species and waterfowl in the same manner as described for waterfowl in the arctic planning areas. These disturbances would be limited to the immediate area around survey vessels, and negative impacts to marine birds and waterfowl would be expected to be minor.

Noise and ship movements from oil transport via tankers and barges could displace seabirds and waterfowl from preferred habitats. Large numbers of seabirds, including shearwaters, storm petrels, fulmars, various alcid species, kittiwakes, loons, grebes, sea ducks, and shorebirds, use open-ocean and shoreline habitats in the lower Cook Inlet and Gulf of Alaska (Forsell and Gould, 1981; DeGange and Sanger, 1986). Limited shipping traffic would be expected to have minor impacts on bird populations; more traffic through prime feeding areas could have moderate impacts. Shipping traffic could impact wintering seabirds in the lower Cook Inlet and the Gulf of Alaska.

Potential contaminants related to oil drilling include drilling muds and cuttings. As discussed previously in the discussion for the arctic planning areas, toxic effects for diluted drilling muds are low and negative impacts to marine bird species would be expected to be minor.

The short-tailed albatross is a pelagic species that could wander north from western Pacific breeding grounds to the subarctic planning areas. Short-tailed albatross are surface feeders and frequently sit on the ocean surface. Impacts from oil exploration and production would be similar to those described for other seabirds and waterfowl. Since short-tailed albatross would not be expected to come ashore, impacts would be confined to those that would occur at sea. The numbers of albatross expected to occur in the affected area would be confined to occasional sightings of individual birds, and impacts related to oil exploration and production would be negligible and would not be expected to affect short-tailed albatross populations.

The Aleutian subspecies of the Canada goose has been delisted. Few birds would be expected to occur in the subarctic planning areas, and routine operations related to oil exploration and production would be expected to be negligible.

Marbled murrelet, a species of concern at the Federal level, is a common winter migrant in the subarctic. The impacts on this seabird from routine operations for oil exploration and production in the lower Cook Inlet would be similar to those described for other nonlisted seabird species. Potential impacts would be expected to be negligible to minor.

4.3.3.5.2. Accidents

Arctic

Offshore oil spills present the greatest large-scale threat to negatively impact birds, as evidenced by numerous oil spills that have occurred throughout the world. Waterfowl and seabirds are particularly susceptible to oil spills because they would be the most likely species to come in contact with offshore spills. Oil-covered feathers lose their insulating capabilities, and birds become hypothermic. Oil can also be ingested from the feathers of preening birds and have toxic effects (Hansen, 1981). The survival rate for oiled birds is low. In addition, many marine bird species have low reproductive rates and a slow maturity rate. Population recovery from high adult mortality during a large oil spill could take many years, and impacts could be major.

The effects of a large, offshore oil spill can be long term and wide ranging. It is assumed that five large oil spills (Table 4-1e) would occur in the arctic over the life of the proposed action (35 to 40 years). Wind and currents can spread oil over large areas where it may wash up onto beaches and/or contaminate food resources in shallow water. Shorebirds and waterfowl that use salt marsh habitats for feeding and brood rearing can also suffer negative impacts, should oil wash up onto these habitats and contaminate vegetation and invertebrate food sources. Oil that gets into shallow offshore benthic food supplies can also be toxic to waterfowl that feed in these habitats. Effects of contamination of food supplies for birds could have moderate to major impacts on bird populations.

The large numbers of waterfowl (loons, tundra swans, king eiders, long-tailed duck) that use coastal lagoon systems of the Beaufort and Chukchi Seas for late summer through fall molting and staging are spread out over large areas, and casualties from an oil spill during this time could be in the thousands. A winter spill under the ice could produce long-term effects, as oil trapped under the ice could contaminate leads that develop during breakup. Eiders and other waterfowl use ice leads while migrating. Depending on the size of the oil spill, impacts to waterfowl could be moderate to major.

Common eiders, gulls, and other birds nesting on barrier islands in the Beaufort and Chukchi Seas and birds nesting in coastal salt marsh habitats could be seriously impacted by a large oil spill affecting these habitats. Large colonies at Capes Lisburne and Thompson represent a potential for major oil-spill effects. Colonial nesting murres and kittiwakes at the southern edge of the arctic planning areas in the Hope Basin also could be impacted severely by an oil spill in that area. Aside from direct contact with oil, eggs of nesting birds may become contaminated from oiled feathers of incubating adults that produce toxic effects on chick embryos (Patten and Patten, 1979; Stickel and Dieter, 1979).

Oil spills from pipelines in terrestrial habitats may have less negative impacts than offshore spills because oil contaminants presumably would be contained in a smaller area (unless the spill enters a stream). The spreading effects of ocean currents and wind would not apply. Oil leaks from terrestrial pipelines could cause contamination of eggs and feeding areas of tundra nesting birds such as shorebirds, passerines, ducks, geese and swans, loons, gulls, and terns. Minor to moderate impacts could be expected to occur at sites of terrestrial oil spills.

Spectacled and Steller's eiders breed in coastal wetlands of the arctic slope of Alaska and in Russia. Most spectacled eiders probably use overland routes across the arctic coastal plain during spring migration but may use overland and offshore routes during fall migration (Troy Ecological Research Associates, 1999). Steller's eiders are reported to migrate both inland across the arctic coastal plain (Myers, 1958), and offshore (Johnson and Herter, 1989) during spring migration. During this time, eiders would be particularly susceptible to oil spills because relatively large numbers of birds would be moving from one area to another. This would increase the possibility of more birds coming into contact with oil as they stop to feed and rest along the migration route. Even a relatively small spill may have the potential to affect a large number of eiders. Major negative impacts related to oil spills could also take place during the fall molting and staging period in the Chukchi and Bering Seas, when flightless birds are using coastal lagoons and bays.

Subarctic

Oil spills present the greatest potential threat to negatively impact marine and coastal bird species in the subarctic planning areas. The proposed action assumes one large pipeline spill in Cook Inlet and one large tanker spill in the Gulf of Alaska over a 25-year period (Table 4-1e). The effects of an oil spill in the region would be similar to those in the arctic planning areas. A large oil spill in an area of high bird use could affect thousands of birds, causing high mortality. Oil contacting feathers directly can cause birds to die from hypothermia or drowning, or oil ingested by preening birds may be toxic. Oil may also contaminate waterfowl and shorebird food sources such as benthic invertebrates and plant materials. For nesting birds, eggs may become contaminated from oiled feathers of incubating adults and produce toxic effects on chick embryos. Impacts on bird populations would be moderate to major, depending on the amount and location of the oil spill.

A large oil spill may be moved by wind and currents and may affect birds directly or may contaminate food sources over a large area. Shallow nearshore benthic habitats used by diving ducks for feeding could be negatively impacted, as could intertidal feeding habitats used by shorebirds. Large areas of open water used by surface feeding species could also be contaminated. Currents in the lower Cook Inlet could move an oil spill into the Shelikof Strait, which is a high use area for marine birds and waterfowl (Forsell and Gould, 1981), and negative impacts could be major. The probability of a large oil spill in Cook Inlet is 35-40 percent.

The effects of contamination of prey organisms or other food sources can be long term and result in reduction of reproductive capabilities of predator species (Patten, 1993). Recovery times for predator species can be lengthy and last for a number of years. The extent of the impacts could be moderate to major**,** depending on a number of factors including size of the oil spill, effects of wind and currents, quality and quantity of affected habitat, and number of birds using the affected area.

An oil spill in the subarctic planning areas can negatively impact birds at any time of the year (DeGange and Sanger, 1986). Seasonal shifts in bird populations are largely the result of migration, and numbers of birds using the planning areas may be in the millions. Huge concentrations of birds occur during spring migration, when large numbers of waterfowl and shorebirds pass through the area. Waterfowl and shorebird numbers decline during the summer as these birds continue migrating north. At this time, numbers of breeding gulls, cormorants, and alcids increase, as do numbers of seabirds such as fulmars and storm petrels. Millions of short-tailed shearwaters also migrate through the Gulf of Alaska and the Bering Sea each year. In the fall, bird densities drop as gulls and sea ducks depart and alcids move to pelagic waters. At this time, dabbling duck and goose densities increase. Winter population densities are lower than other times of the year, as most gulls and migrating waterfowl have departed. Sea ducks and sea birds are the most common groups during the winter. The Shelikof Strait and Kodiak Island area are wintering areas for a large number of cormorants, long-tailed ducks, king eiders, scoters, and alcids (Forsell and Gould, 1981).

Piatt and Ford (1996) estimated that the *Exxon Valdez* oil spill in March 1989, resulted in the mortality of approximately 250,000 seabirds. Estimates of mortality can be made using three general approaches: measuring pre- and post-spill colony populations; estimating carcass loss and recovery rates from experimental drift studies conducted during the actual spill; or conducting carcass drift and recovery studies at other times and places. These methods are associated with inherent uncertainties and sources of error that cannot be evaluated; however, taken together there seems to be agreement in the order of magnitude indicating that the estimate is probably a reasonable one. Earlier research by Piatt et al. (1990) indicated that nearly 75 percent of the mortality was common murres, 7 percent were other alcids, and 5 percent were various sea ducks. The Exxon Valdez Oil Spill Trustee Council 2001 status report indicates that the bald eagle (estimated 4% Prince William Sound population killed) recovered in 1996; the black oystercatcher, common murre, and marbled murrelet are recovering. The oystercatchers are reoccupying and nesting at once-oiled sites, and there are no oil-related impacts on productivity and chick survival. The common murre (estimated 40% of the local population killed) had returned to pre-spill population numbers by 1997, and then the 1997 El Niño caused a temporary setback. Currently, the Barren Islands population has recovered, and Chiswell Islands surveys will be available soon. The marbled murrelet (estimated 7% loss of local population), which lost about 67 percent of its Prince William Sound population since 1972, experienced increased numbers in the winter after the spill and has productivity levels within normal bounds. Not enough is known about Kittlitz's murrelet to determine its recovery status. Long-lived, slow-reproducing loons; diving, fish-eating cormorants and pigeon guillemots; and intertidal harlequin ducks have not yet recovered from the *Exxon Valdez* oil spill. These effects might be attributed to persistent oil remaining in the environment that reduced forage fish (Irons et al., 2000; Murphy and Mabee, 2000). Agler et al. (1999) point out difficulties of assigning cause and effect for some of the bird species in Prince William Sound since some population declines in the Gulf of Alaska, Bering Sea, and coast of California are partially attributable to climatic shift and overfishing that have changed forage-fish abundance.

Seabird colonies are located in coastal areas and on islands through lower Cook Inlet and southeast Alaska to California. A tanker spill anywhere along the TAPS shipping route could impact large numbers of birds using these waters for feeding during both breeding and nonbreeding seasons, and impacts could be moderate to major, depending on the amount and location of oil spilled. Much of the Steller's eider population molts along the Alaskan coast from Nunivak Island to Cold Bay. Steller's eiders winter in shallow, nearshore marine habitats from the Aleutian Islands to lower Cook Inlet, where they feed on benthic invertebrates and amphipods. Molting and wintering birds could be affected by oil spills from a TAPS tanker in the Gulf of Alaska, either by direct contact with oil, ingestion of oil from preening oil soaked feathers, or from contaminated food sources. Whether impacts would be moderate or major, depends on the amount and location of an oil spill.

The Aleutian Canada goose spends time in marine habitats. An oil spill in the lower Cook Inlet that spreads southwest toward Kodiak Island could impact some birds at the eastern end of their range. Negative impacts from an oil spill could be minor to moderate, depending on the size and location of the spill.

Offshore oil spills present the greatest threat to negatively impact marbled murrelets. An oil spill from tankers transporting TAPS oil to west coast ports could impact murrelets in nesting areas along the coast of Alaska. Impacts to marbled murrelets from such a spill could be minor to moderate, depending on the size, location, and timing of the spill.

An offshore oil spill that spreads to onshore habitats would have the potential to impact a small number of peregrine falcons that may be feeding on waterfowl and/or shorebirds. Negative impacts would involve a small number of birds, and only minor impacts would be expected.

Two birds of prey are also coastal residents in the subarctic planning areas and could be negatively impacted by an oil spill. Bald eagles are common nesting birds that are primarily fish eaters or scavengers. Although no longer endangered, they are afforded protection through the Bald Eagle

Protection Act. Eagles could be affected by contaminated food on oiled beaches. Peregrine falcons also nest in the area and prey on waterfowl and shorebirds. Peregrines may be less likely than bald eagles to ingest contaminated food because they are not scavengers. Impacts to these species are expected to be minor.

If a gas condensate spill were to occur in Norton Basin during the winter, it would likely have no immediate effects on birds unless it were to contact overwintering waterfowl and alcids in ice leads and polynyas. If the spill were to occur in open water, only small numbers of birds would be expected to be affected by the spill because condensate would disperse and evaporate rapidly.

Conclusion: Potential impacts on marine and coastal birds due to routine operations in the arctic range from **negligible to minor**. Potential impacts on nonlisted bird species due to routine operations in the subarctic range from **negligible to moderate**. The moderate level impacts could result if there were constant ship traffic through prime areas for feeding.

Potential impacts to threatened or endangered birds, if a large oil spill were to occur and contact bird habitat, range from **minor** to **major**. Level of impact would depend on size and location of the spill. Potential impacts on nonlisted bird species due to oil spills in the arctic and subarctic could be **minor, moderate, or major**, depending on the size, location, and timing of a spill.

4.3.3.6. Fish Resources

Impacts of OCS oil and gas development on Alaskan fish populations may accrue from exploratory surveying and drilling, equipment placement and removal, operational discharge of fluids and oil, and accidental oil spills. These activities can have immediate, lethal, or long-term sublethal effects on fishes.

4.3.3.6.1. Routine Operations

Seismic survey data are usually collected by discharging compressed air from arrays of airguns towed behind ships. The effects of airgun discharges on fishes depend on fish life stage and biology, distance to and type of the sound source, and the size of the explosion. Pelagic fish species contain swim bladders that help control buoyancy. Several studies have found that species with swim bladders (e.g., salmonids, coregonids, and gadids) are more vulnerable to injury or mortality from explosions than species without swim bladders, because airgun discharges may damage air or gas-containing organs (USDOI, MMS, 1996d).

Acute damage to adult and juvenile fishes from airgun discharges appears confined to a radius of 1.5 m from the blast, and the approaching noise source probably scares mobile fishes away before the airgun comes within this range (Davis et al., 1998). The juvenile and adult fish most likely to be affected by the noise generated from seismic surveys in the arctic regions include the five species of salmon, the cods (e.g., Walleye pollock found throughout the subarctic areas), cisco, herring, sablefish, and rockfish. Flatfishes (e.g., Pacific halibut) lack swim bladders and would be least impacted by airgun discharges. Acute, lethal effects of seismic survey airgun blasts on adult pelagic fishes are likely to be negligible where waters are of sufficient depth and fishes have the opportunity to escape. Young-of-the-year fish (i.e., arctic cisco) are transported by wind-driven currents and may not be able to move from an area of impact. Still, the effect to the overall fish population would be negligible since fishes are distributed over wide geographic areas and airgun operations are very localized. Temporary displacement of fishes is the most probable effect of noise generated by seismic surveys, and would be negligible.

Fish eggs and larvae are more sensitive than adults to injury and mortality from airgun discharges. Eggs and larvae of many fish species are also more likely to come into contact with airgun discharges because eggs drift passively near the ocean surface and larvae often rise diurnally in the water column when feeding on zooplankton (Davis et al., 1998). In the arctic regions, the fish eggs and larvae that drift offshore (e.g., cod, pollock, halibut) are most likely to be impacted by noise associated with seismic surveys. Anadromous and amphidromous fish eggs and larvae that are laid in and grow to the juvenile stage either in fresh or brackish water would not be affected by offshore airgun discharges. Acute, lethal impacts of seismic surveys on fish eggs and larvae would likely be moderate because the effect would be localized, but would depend on location and time of year.

Equipment placement activities may include dredging for pipelines, installation of support pilings, and possible construction of artificial islands (Table 4-1b). Removal of equipment would involve lifting platforms and other equipment off the seafloor. These activities can directly affect fishery resources by disturbing the ocean floor and increasing water turbidity. Resuspended sediments can also release pollutants and smother benthic organisms.

Turbidity caused by pipeline installation and removal may decrease photosynthesis of plankton at depths down to 100 m, affecting primary productivity (USDOI, MMS, 1996c). In the arctic regions, arctic cod would be directly impacted by curtailed plankton productivity in the areas of pipeline installation and removal. Arctic cod would likely pursue an alternate plankton supply, displacing an important forage fish from the location of disturbance. Arctic cod displacement could directly affect apex consumers through a loss of food source. These fish and the consumers affected by these activities are likely to return after the disturbance has dissipated.

The deposition of sediments suspended by pipeline dredging is likely to have the greatest impact on immobile benthic organisms. Lethal effects include smothering, whereas sublethal effects include bioaccumulation of metals and hydrocarbons, the long-term effects of which are unknown (USDOI, MMS, 1996a). Estimates of recovery time for directly impacted benthic communities range from 3 to 10 years (USDOI, MMS, 1996a, d). Impacted benthic communities could directly affect demersal fishes and shellfishes (e.g., sablefish, Pacific cod, and crab) that would likely relocate to an area that provides an uncontaminated food source.

The effects of pipeline installation and removal under the proposed action on populations of immobile benthic organisms could be mid to long term (years) and localized. Its impacts to fish resources could be minor.

The platform placement would also introduce an artificial, hard substrate that opportunistic benthic species could colonize. Fishes may be attracted to the newly formed habitat complex. Population numbers in the immediate vicinity of the platforms are likely to be notably higher than the surrounding waters away from the structures. The very small number of platforms projected for the Alaska planning areas (Table 4-1b) (with a maximum 40-year life span) would create a small amount of habitat and likely have a minor effect on the overall fish populations.

Artificial islands are sometimes constructed to support drilling operations and are typically constructed of gravel and rubble substrate. These islands increase the diversity of habitat available on otherwise homogeneous ocean floors (USDOD, 1998). Motile benthic organisms that require fine sediment habitat will be killed or displaced to adjacent undisturbed areas. Immobile benthic organisms will be killed during the construction. Benthic and other marine species that prefer gravel substrate may be attracted to the island. Increased substrate heterogeneity could also increase the production of benthic marine invertebrates that may lead to a localized increase in foraging species. The overall change in habitat could result in changes in local community assemblage and diversity

(Howarth, 1991). This alteration could completely displace apex consumers from the vicinity, for the short-term duration of the construction. Although the increase in local abundance of some species has been touted as beneficial by some reports (USDOI, MMS, 1996d; USDOD, 1998), rapid changes in community assemblage due to anthropogenic disturbance are rarely beneficial to the entire community and can have latent drawbacks. The effects of artificial island construction on aquatic organisms will be moderate because the effects would be localized and long term or permanent.

Drill muds and cuttings (Table 4-1b) are routinely discharged into the water column and typically settle within 2,000 m of the well. The discharge plume may reduce local photosynthesis by increasing turbidity and may smother immobile benthic organisms. Metals and chemicals in the deposited materials may bioaccumulate. The discharge plume may also affect the dissolved oxygen (DO), temperature, acidity, and salinity near (40 m) the source (USDOI, MMS, 1996a). The localized effect would directly impact demersal fishes (e.g., rockfish and Walleye pollock) and shellfishes (e.g., crabs) that feed on plankton or benthic organisms in the immediate vicinity. A reduction in phytoplankton production would directly affect arctic cod and ultimately their predators in the vicinity of the discharge. Arctic cod and their predators would likely be displaced from the area of the discharge plume.

Produced water is often the single largest source of material discharged during normal operations. Produced water can be disposed of by re-injection into disposal wells, by transporting water onshore, or by discharging water into the ocean. Produced water discharged near the ocean floor may disperse slowly and cause thermal and DO gradients. This could directly impact and displace demersal fishes (e.g., Pacific halibut) and shellfishes (e.g., shrimp) in the immediate vicinity of the effluent. Produced water discharged higher in the water column usually disperses before temperature and DO gradients can form (USDOI, MMS, 1996a).

Effects of produced waters appear to be more chronic than acute and may have the most adverse impacts on marine benthic organisms. These adverse impacts may be the strongest when produced waters are released in low-energy, shallow-water environments over long time periods such as years (Howarth, 1991).

Activities associated with exploration of oil and gas resources in Norton Basin could have several effects on fish. It is expected that the hydrocarbons found in the Norton Sound area will include only gas. Effects on fish due to gas and gas condensates are expected to be very low.

Habitat disruption and increased turbidity due to platform and pipeline construction are expected to have little effect on fish. Effects from other activities (seismic exploration and discharge of drilling muds) should be localized, and recovery should be accomplished in 1 to 2 years. The effect of these activities on fish is expected to be very low.

Considering the level of activity expected from the proposal and the distribution of fish resources, discharges from routine oil and gas operations are expected to produce minor impacts to fish resources of the Alaska Region.

Local residents are not always explicit about the specific causal factors for perceived effects, but clearly link potential impacts on fish to oil and gas activities. Such public comments on the North Slope relating to whitefish near Nuiqsut date from at least 1979, when Wilber Ahtuangaruak stated that there "aren't as many whitefish since the oil companies started drilling at Flaxman Island" (USDOI, MMS, 1979c). The Endicott development with its associated causeway was also a source of great concern: "The causeway sticking out into the ocean will change currents along the coast. Furthermore, it will change the migration route of the fish we depend on" (Thomas Nupagiak in U.S.

Army Engineer District, Alaska [USAEDA], 1984a). Nuiqsut residents have reported decreased and variable fish harvests since the construction of the causeway (USDOI, Bureau of Land Management [BLM] and USDOI, MMS, 1998; also cited in USDOI, MMS, 2001). Isaac Nukapigak of Nuiqsut reported that cisco are not spawning out near the Colville River delta anymore, attributing this change to oil activities taking place in State waters (during a 1995 Beaufort Sea Sale 144 Workshop, as cited in USDOI, MMS, 2001).

4.3.3.6.2. Accidents

Oil spills (Table 4-1e) can have both acute, lethal effects and chronic, sublethal effects on fishes (Howarth, 1991). The magnitude of these effects depends upon spill size, oil type, season, environmental characteristics of the receiving water, weather conditions, food chain complexity, and the species ultimately contacting oil from a spill (Rice et al., 1984b; USDOI, MMS, 1996a).

Acute and Lethal Effects

The sensitivity of marine biota to short-term oil exposure generally increases with trophic level. Within species, sensitivity to oil can change substantially from one life stage to the next. One of the most consistent trends is the correlation between habitat and susceptibility. Pelagic organisms, which inhabit relatively stable habitats, typically are more sensitive to oil exposure than intertidal organisms, which inhabit relatively variable environments (Rice et al., 1984b). Fishes are generally more susceptible to oil exposure as embryos and larvae because these early life stages lack organs to detoxify chemicals, are incapable of moving to avoid exposure, and are often concentrated near the surface where they are most likely to be exposed to oil (USDOI, MMS, 1996a). Although intertidal species may be able to withstand higher levels of oil exposure, they are also generally less mobile and thus less likely to avoid oil driven ashore (Rice et al., 1984b).

Pelagic fish species (e.g., salmon and herring) are relatively mobile and should be able to avoid surface oil in the offshore environment. Mature salmonids move inshore to spawn, however, and thus may be exposed to oil during reproductive migrations. Juvenile salmonids must migrate seaward through these same inshore habitats and are likely to come into contact with oil spills driven inshore. Salmonid eggs and alevins appear less sensitive to short-term (96-day) oil exposure than salmonid fry (Rice et al., 1984b). Overall, salmonids are most sensitive to acute effects of oil while juveniles, and are most likely to be affected when exposed to oil in nearshore areas where oil avoidance is difficult.

Some pelagic species (e.g., Pacific herring) also spawn in intertidal zones where their eggs may be susceptible to oil. (Rice et al., 1984b). Herring generally spawn near shorelines over 3-4 week periods, and oil driven onshore could contact spawning adults and incubating eggs (USDOI, MMS, 1996d). Larval herring are also susceptible after moving into deeper water because they rise diurnally to feed on plankton and can thus be exposed to surface oil repeatedly during the period that oil is present.

Demersal fishes such as walleye pollock, halibut, and cod all have buoyant eggs and larvae that float near the surface, where they are most likely to be exposed to spilled oil (USDOI, MMS, 1996d).

Shellfish and crustaceans are most susceptible to acute effects from oil exposure during egg and larval stages when they are closest to the water surface. Shrimp also inhabit the upper water column as adults and juveniles, and are thus at risk of exposure throughout their life cycle. Clams that inhabit the intertidal zone are susceptible to oil exposure as both juveniles and adults.

Sublethal and Chronic Effects

Petroleum hydrocarbons can have numerous sublethal effects on fishes, and are known to alter behavior (e.g., feeding, predator avoidance), physiology (e.g., respiration, growth), physical development, pathogen resistance, and organ structure (Rice et al., 1984b; Howarth, 1991; USDOI, MMS, 1996d). Fishes can incur sublethal effects well below the acute lethal dosages (Moles et al., 1981; Urho, 1990). Although numerous sublethal effects have been documented, many may not have been identified yet because they act over long periods of time and are thus difficult to detect. When spilled, petroleum hydrocarbons may persist for years (Howarth, 1991; Wiedmer et al., 1996), especially in sediments of the cold waters of the Alaskan subregions, making it likely that some fish species would be exposed to low levels of hydrocarbons for an extended time after an oil spill.

Oil exposure is known to slow growth of demersal fishes (e.g., flounder; Howarth, 1991), pelagic fishes (salmon fry and alevins; Moles et al., 1981; Wertheimer and Celewycz, 1996; Willette, 1996), and shellfish (mussels; Rice et al., 1984b). Oil exposure reduces growth when fishes shunt energy from growth to hydrocarbon metabolism and excretion (Rice et al., 1984b; Willette, 1996).

Reduced growth can impair egg development, fish feeding rate, predator avoidance, and migration to suitable habitat and could, therefore, make survival in natural environments unlikely (Rice et al., 1984b; Howarth, 1991). Reduced growth may be caused by reduced food conversion rates, rather than because of reductions in feeding (Vignier et al., 1992).

Oil exposure can also affect feeding, predator avoidance, and migratory behavior of fishes. Coho salmon have consumed fewer prey when exposed to oil, and chum salmon fry were more vulnerable to predation after being exposed to oil (Malins et al., 1981). Migratory behavior of fishes may be disrupted when fishes alter normal migratory routes to avoid oil. Adult salmon may be unable to return to local spawning grounds if these grounds are blocked by oil (USDOI, BLM, 1981). Juvenile salmon may suffer increased predation if they deviate from normal migration routes to avoid oil (Willette, 1996). In addition, petroleum hydrocarbons may reduce the homing ability of salmon by damaging olfactory tissues (Babcock, 1985).

A few weeks after the *Exxon Valdez* oil spill, the Pacific herring (*Clupea pallasi*) spawned in Prince William Sound (Brown et al., 1996). About 40-50 percent of the egg biomass from this spawning sustained oil exposure during early development. The resulting year-class exhibited sublethal effects including premature hatch, low weights, reduced growth, and increased morphologic and genetic abnormalities. A substantial decrease in year-class was observed but could not be estimated because natural processes affecting recruitment are poorly understood. The 1989 year-class was a minority of the 1993 spawning population, and the adult population was reduced by approximately 75 percent, apparently because of a widespread epizootic.

Acute effects of PAH's have been well documented. Only within recent years have the long-term, chronic effects of PAH's on fish been studied. After the 1989 *Exxon Valdez* oil spill in Prince William Sound, field and laboratory research were expanded to include analysis of chronic effects of PAH's on pink salmon, which at the time of the spill was one of the most valuable fisheries in Prince William Sound.

Research was conducted by both industry and government scientists (Rice et al., 2001). In many cases, study results from the different groups conflicted or contradicted each other. However, sufficient research was completed to indicate that chronic exposure of some fish species to PAH's could have long-term effects. The Natural Resource Damage Assessment (NRDA) found that pink salmon fry that had migrated through spilled areas in 1989 had depressed growth rates. Their field studies indicated that elevated embryo mortality in pink salmon continued through 1993. Scientists have hypothesized that high molecular weight PAH in weathered oil leaches from oil stream banks into salmon redds, recontaminating these areas.

Results of laboratory studies designed to closely resemble postspill conditions in Prince William Sound indicated that embryos were negatively affected by long-term exposures to weathered oil in the low part per billion range for PAH. Mortalities, abnormalities, histopathological damage, and other biological effects increased with embryo exposure to these levels of PAH concentrations. Parallel studies on the Pacific herring (Clupea pallasi) indicated similar results. The NRDA researchers concluded that long-term damage in the pink salmon population in Prince William Sound, as a whole, was not evident. The population collapse of 1992 and 1993 was significant in Prince William Sound, but direct linkage to oil toxicity was difficult to prove. Long-term oil impacts at the stream level were likely, but populations rebounded quickly. This was most likely due to the short 2-year life cycle of the pink salmon and the influence of strays.

Prior to this research, it was unclear that PAH's could have chronic, long-term effects on fish. It was also thought that the level of PAH exposure had to be greater than parts per billion to produce recognizable impacts on fish. These data are especially applicable in an environment such as an urban estuary where there would be regular and repetitive inputs of PAH's from oil and other sources. Under these conditions, chronic and long-term effects on the early life stages of many fish species would be expected. This could influence the viability of future generations and whole populations.

Stress from oil exposure alters fish respiration and metabolic rates. Salmon fry exposed to oil breathed faster and consumed more oxygen, and king crab exposed to oil consumed less oxygen and had increased heart rates (Rice et al., 1984b). Pacific herring eggs exposed to oil from the 1989 *Exxon Valdez* oil spill had faster hatch times and lower posthatch body weights than nonexposed eggs (Brown et al., 1996).

Oil exposure has caused gross physical abnormalities in numerous fishes and shellfish. Chum salmon, smelt, and sole eggs and larvae exposed to oil all incurred gross physical abnormalities (Malins et al., 1981). Molting Tanner crabs exposed to sublethal concentrations of oil autotomized (voluntarily shed) legs at rates that increased with exposure concentration (Karinen and Rice, 1974). Oil exposure also suppressed Tanner crab molting. Herring exposed to oil spilled from the tanker *Antonio Gramisci* in the Baltic Sea in 1987 had livers twice as large and gonads half as large as unexposed herring (Urho, 1990).

Fishes may need to divert energy from immune functions to metabolize and excrete petroleum hydrocarbons, making them more susceptible to disease and parasites. Coho salmon fry experimentally exposed to different levels of parasitism from the freshwater mussel *Anodonta oregonsis* were more sensitive to petroleum hydrocarbons as the level of parasitism increased (Moles, 1980). When pathogens make an organism more susceptible to pollution stress, such as with coho salmon fry, pollution stress could make the organism more susceptible to pathogen infections (Moles, 1980).

Hydrocarbons can remain in sediments for an extended period of time before breaking down and may thus be available for uptake and bioaccumulation by benthic organisms for years (Howarth, 1991). Commercially important fishes (e.g., Pacific cod, sablefish, and crab) may be particularly susceptible because of their dependence on benthic forage. Petroleum hydrocarbons are known to bioaccumulate in fishes and represent a long-term sublethal threat to the food chain after an oil spill. Hydrocarbons also readily accumulate in herring, and thus have substantial implications for the ecosystem and for human consumption. Hydrocarbons bioaccumulate in herring muscle and ovarian tissue at exposure levels well below lethal concentrations (Rice et al., 1986). Muscle and roe are commercially important, and the accumulation of hydrocarbons at such low exposure levels has important ramifications for commercial fisheries (Rice et al., 1986). In addition, herring are a critical link in the marine food chain because they convert plankton to fish biomass (Outer Continental Shelf Environmental Assessment Program [OCSEAP], 1987) and could thus serve as a substantial vector for the bioaccumulation of hydrocarbons in higher trophic levels.

Effects of Oil Exposure (Arctic)

A recently published study, "*ANIMIDA Phase I: Arctic Nearshore Characterization and Monitoring of the Physical Environment in the Northstar and Liberty Development Areas"* (Boehm, 2001), found that existing concentrations of hydrocarbons and metals in the sediments are lower than Effects Range-Low benchmarks. Effects Range-Low and Effects Range-Medium are a set of criteria introduced by Long et al. (1995) that are based on field, laboratory, and modeling studies conducted in the United States and coupled concentrations of contaminants in sediments with adverse biological effects. The study found that small incremental contaminant additions from future development activities are not likely to pose any immediate ecological harm to marine organisms in the Beaufort Sea study area. Concentrations of hydrocarbons and metals in clams and amphipods were within the range of previous studies in the region. Elevated concentrations in sediments, from natural sources, "do not appear to be readily bioavailable to marine filter-feeders and deposit feeders" (Boehm, 2001), which are prey for many benthic fish species.

Polycyclic aromatic hydrocarbons (PAH's) are composed of carbon and hydrogen arranged in the form of two or more fused aromatic (benzene) rings, and are associated with carcinogenesis. Marine sediment samples analyzed for total PAH concentrations in both the Liberty and Northstar regions were recently shown to be in the low range (330 micrograms per kilogram [μg/kg] and 380 μg/kg respectively). Total PAH concentrations measured at the nearshore Beaufort Sea Monitoring Program areas (Foggy Island, Endicott Field and Kuparuk River) were generally within the same range, with means of 290 μg/kg and 340 μg/kg for the Foggy Island and Endicott Regions, respectively. Excluding results for Station 5D (West Dock), the regional Total PAH concentrations for Kuparuk River Bay region is 270 μg/kg. Station 5D had total PAH concentrations of 2,700 μg/kg, nearly an order of magnitude higher than the means for the other regions. This result suggests there may be PAH contamination at this station, which is adjacent to an area of high construction and development activity.

The Beaufort Sea subregion contains demersal, anadromous, and pelagic fishes that are both resident and migratory. Subsistence fishing is important to the region (see Section 4.3.3.12), and a small commercial fishery for arctic and least cisco (see Section 4.3.3.12) operates on the Colville River delta (USDOI, MMS, 1996c).

The most abundant marine species are arctic and saffron cod, fourhorn sculpin, eelpout, and arctic flounder (USDOI, MMS, 1996c). Of these, the arctic cod may be the most susceptible to lethal oil effects because the larvae are pelagic and most likely to come into contact with oil. Arctic cod are also susceptible in that they are dependent on primary (plankton) production that may be impacted directly by oil exposure. Arctic cod are distributed throughout the region, and a localized spill event would be unlikely to have a substantial impact on the population in the overall region. A large spill that contacted arctic cod eggs and larvae could have a minor effect on the population. A large oil spill that destroyed plankton in arctic cod feeding grounds would displace the fish and cause a minor impact.

The most abundant anadromous species are the arctic and least cisco, broad whitefish, Dolly Varden, and rainbow smelt (USDOI, MMS, 1996c). Most of these populations appear to originate from the Colville and Mackenzie River systems. Fishes most likely to be affected by a large oil spill are those that migrate extensively (arctic cisco), with high fidelity to natal streams (Dolly Varden), and those confined to nearshore environments (broad whitefish, rainbow smelt). Oil spills would be most likely to have population-level consequences if they were to contaminate critical habitat areas (e.g., the Colville River delta) or to expose fishes at a time when the population was highly concentrated (e.g., spawning areas or juvenile feeding grounds). A large spill could cause a moderate consequence to fish populations under these circumstances (e.g., the arctic cisco population concentrated near the Colville River). Small spills could create minor impacts to fish populations in the same circumstances.

Young-of-the-year fish (i.e., arctic cisco) are passively transported by wind-generated coastal currents and may not be able to avoid oil contaminated areas. The resulting prolonged exposure could cause minor impacts from an oil spill.

An important, indirect effect of an oil spill would be the contamination of fishes relied on for subsistence (e.g., arctic and least cisco). In terms of fish biota, the Chukchi Sea is a transition zone between the fish communities of the Pacific and Arctic Oceans. Subsistence fishing is critical to the coastal villages, and a small commercial salmon fishery occurs in the subregion. Petroleum contamination of fishes could have severe consequences if it affected the fishes harvested by these villages.

The most abundant fish species are generally forage fishes that sustain seabirds and marine mammals. Of these forage fishes, the most abundant appear to be arctic cod, Pacific sand lance, sculpin, and Pacific herring (Craig et al., 1984b). Relatively few anadromous species appear to return to coastal rivers along the Chukchi Sea. Pink and chum salmon are present, but the relative proportions of individuals from local vs. distant streams (e.g., from the Bering or Beaufort Seas) are unknown (Craig et al., 1984b).

Oil spills probably represent the greatest hazard from OCS oil and gas development to the fish species in the Chukchi Sea. Of these fish species, pink salmon, herring, and capelin are the most susceptible to oil spills because they spawn, hatch, and rear in inshore areas that could be contaminated following a spill. If a population of these fishes were concentrated in an area during their more vulnerable life stages (i.e., eggs and larvae), exposure to a large spill could have a major impact. Adults exposed in a similar situation would likely experience moderate impacts. It is not known whether these stocks represent isolated, endemic populations or whether they are contiguous with North Pacific and Beaufort Sea populations. An oil spill that damaged populations would have longer term effects if the populations are endemic than if they are contiguous with other, more abundant, populations (Craig et al., 1984b).

Effects of Oil Exposure (Subarctic)

The lower Cook Inlet subregion contains commercially important pelagic (salmon) and demersal (Pacific cod, Pacific halibut, pollock, sablefish) fish species, as well as biologically important populations of forage fishes (herring, eulachon, sand lance, and capelin). Of these species, sand lance, salmon, and herring are probably the most vulnerable to spills (Table 4-1e) because of their extensive dependence on inshore habitats throughout several life stages.

Salmon in Cook Inlet depend on inshore areas for adult migration, spawning, larval growth, and juvenile rearing and migration. Of all the salmon, pink salmon are probably the most susceptible to oil spills because they often spawn in intertidal zones and can thus be exposed at several life stages (USDOI, BLM, 1981). Because of the wide distribution of salmon populations in Cook Inlet, if a large spill were to reach the pink salmon spawning grounds it could create a moderate impact to the resource. The impact to adults would be less.

Salmon exposed to sublethal concentrations of hydrocarbons may become contaminated, the possibility of which would result in the closure of local salmon fisheries. Oil spills in Cook Inlet and Prince William Sound have caused salmon fisheries to close because of fear of contamination (USDOI, MMS, 1996b). Cook Inlet commercial salmon fisheries were partially closed after oil spills in 1987 and 1989 (USDOI, MMS, 1996d); similar spills in the future would also be expected to cause both mandatory and voluntary closures of salmon fisheries, and could thus have substantial economic ramifications.

Herring are an important forage fish in Cook Inlet and are particularly vulnerable to oil spills because of their extensive use of shorelines for spawning. Adult herring spawn in subtidal and intertidal zones, and the larvae and juveniles feed and grow in estuaries. An oil spill transported inshore during the herring reproductive season (spring) could thus affect herring populations at all four major life stages (i.e., egg, larva, juvenile, adult). Larval herring generally remain in inshore hatching areas and rise diurnally in the water column to feed on plankton near the surface, thus extending their potential exposure to oil spills. Larval herring may also be killed by shorter exposures and lower concentrations of oil than herring eggs or adults (Rice et al., 1986). A large oil spill that reached herring spawning grounds could have a moderate impact.

Herring may also be susceptible to population-level effects of oil exposure. Herring eggs incur high natural mortality, and small changes can thus be disproportionately important to year class success (McGurk, 1989). Elevated egg and larval mortality from oil spills could thus substantially impact recruitment to maturity, thereby reducing the amount of food available to higher trophic level fishes such as salmon. Petroleum hydrocarbons readily bioaccumulate in herring tissues at sublethal exposures (Rice et al., 1986). Herring are the primary forage base in some areas and are harvested for their flesh and roe. Contaminated herring could be unmarketable to humans, and could serve as a vector to transfer hydrocarbons to piscivorous fishes such as salmon. Herring spawn in several areas of Cook Inlet, throughout the western edge of Kodiak Island, and in at least one area on the west edge of the Shelikof Strait (USDOI, MMS, 1996d).

Halibut larvae carried from the Gulf of Alaska by the Alaska Gyre, the dominant ocean current that circulates counterclockwise throughout the region, may still be pelagic when passing through lower Cook Inlet, and thus may be vulnerable to oil spills on the water surface. Walleye pollock and Pacific cod are abundant in Shelikof Strait and also have pelagic larvae (USDOI, MMS, 1996d). An oil spill contacting dense populations of halibut, pollock, or cod larvae could substantially reduce the recruitment of the year class of regional populations, a moderate impact.

The Gulf of Alaska is critical for the production of the most important commercial fishes in the northern Pacific, including Pacific cod, Pacific halibut, rockfish species, walleye pollock, salmon, herring, and shellfish (crab, shrimp, and squid) (OCSEAP, 1987). The Gulf of Alaska is the source of many fishes harvested in distant regions because fishes that hatch or feed in the Gulf of Alaska are distributed throughout the Pacific by the Alaska Gyre (OCSEAP, 1987). Impacts to these three species in the Gulf of Alaska could affect distant fisheries, ranging from Asia to the coasts of Washington, Oregon, and California.

Salmon are likely to be affected by an oil spill in the Gulf of Alaska because this region is the main nursery for North American salmon. The Gulf of Alaska is known to be the principal feeding ground for Columbia River chinook salmon, all salmon returning to British Columbia, and all salmon returning to thousands of streams in the western Gulf of Alaska and southeastern and central Alaska (OCSEAP, 1987). Salmon are the most economically important species in North America, and the Gulf of Alaska produced an estimated 2.5 x 10^5 thousand tonnes of salmon annually between 1950 and 1977 (Rogers, 1986). The largest threat to salmon from OCS development would likely be an oil spill, which could affect both local and distant stocks. Local stocks would be the most susceptible to oil effects because they could either alter adult migrations back to local spawning streams, or kill juvenile salmon migrating seaward from freshwater. Exposure of early-life stage salmon to a large oil spill could have a moderate impact on their populations in the Gulf of Alaska. Oil spills could also affect distant fish stocks by impacting juveniles on their migration routes to other regions.

The Gulf of Alaska is also critical for the production of local and distant halibut populations. The area near Yakutat is an important nursery area for eggs, larvae, and juveniles that are then transported northward and westward by the Alaska Gyre (OCSEAP, 1987). Halibut eggs are pelagic and float near the surface, where they are susceptible to exposure from spilled oil. A large spill that contacted halibut in their early life stages could have a moderate effect on the resource. Depending on currents, larval and juvenile halibut originating from the Gulf of Alaska may settle out in the Aleutian Islands, the Bering Sea shelf, or near the Pribilof Islands. There is no evidence of halibut eggs or larvae being produced in the Bering Sea, making it possible that the adult halibut population in the Bering Sea is established from halibut hatched in the Gulf of Alaska (OCSEAP, 1987). If so, the exposure of halibut eggs to oil could have substantial, negative impacts on fisheries in western Alaska and the Bering Sea. Local stocks could also be affected by oil that contaminated the sediment, because adult halibut are bottom dwellers vulnerable to bioaccumulation of contaminants. This impact on the fish resource would be minor.

The contamination of subsistence resources is one area of major concern shared by residents of all areas and is the topic of many public comments (Section 4.3.3.12). Oil spills are one obvious potential source of such contamination. Sometimes, such remarks comment on obvious physical abnormalities, and after the *Exxon Valdez* oil spill, such comments were so common that one keyword of the Whiskers! Database (ADFG, 1998) is "abnormalities." Effects do not have to depend on such obvious signs, however, and can be generalized when no contamination may in fact exist. One rural south-central resident stated "we quit eating seals after the oil spill. I didn't trust them. I had a stomachache after eating salmon right after the spill, so I didn't trust anything else" CODE 305-13-042893 (ADFG, 1998).

Conclusion: Potential impacts on fish resources due to routine operations range from **negligible** to **moderate**. Potential moderate impacts include acute, lethal effects of seismic surveys on fish eggs and larvae, and effects of artificial island construction on aquatic organisms that could ultimately affect their consumers.

Potential impacts to fish resources from oil spills under the proposed action are variable and range from **minor** to **moderate**, depending on the size, timing and location of spills. The level of impact also depends on the species and numbers present and life stage. Moderate effects of spills are likely to be on a local level, and fish populations are expected to recover over time.

4.3.3.7. Coastal Habitats

Routine Operations

Small coastal habitat areas will be lost at areas of landfalls and placement of vertical support members for aboveground, onshore pipelines. Construction of a new shore base and process facility for the Chukchi Sea, Hope Basin, and Norton Basin Planning Areas would also disturb relatively small areas of coastal habitat, as would roads associated with these developments (Table 4-1b). Indirect impacts of gravel placement for facilities include dust and changes in drainage patterns that may alter plant communities near the sites where gravel is placed (Walker et al., 1985; Aurbach et al., 1997). Altered drainage patterns in tundra environments can create impoundments and additional habitat loss via thermokarst (Walker et al., 1987a,b). Siting of facilities away from more sensitive areas such as river deltas and salt marshes and with attention to natural drainage patterns will minimize habitat loss.

Arctic ice road construction and use, if onshore, may disturb vegetation by compaction and breaking of plants, particularly shrubs, under the ice. Delayed melt caused by the ice road will also impact vegetation (Walker et al., 1985). Most tundra areas recover from ice roads over a period of several years. It is expected that much of the ice road construction will occur offshore, where such effects are absent.

In the arctic, tidal fluctuations are low, and relatively little intertidal habitat is present. Intertidal benthic habitats are most prevalent in river estuaries and deltas where wind and variation in amount of river water outflow are more important factors in exposing benthic habitats than tidal fluctuations. Some important river delta systems include Canning River delta, the Colville River delta, and the Fish Creek delta (located just west of the Colville River delta) in the Beaufort Sea Planning Area (Figure 3-25). Intertidal benthic habitats may also occur in some of the coastal lagoon systems such as the Kasegaluk Lagoon near Icy Cape in the Chukchi Sea Planning Area (Figure 3-25).

Invertebrate communities that live in benthic habitats are lower trophic-level organisms that serve as important food sources for fish and bird species. Benthic invertebrates in intertidal habitats include mobile crustaceans such as amphipods, isopods, and mysids, as well as sedentary polychaetes and bivalves. Aside from potential effects of disturbances related to oil exploration and production, arctic benthic communities are subjected to natural disturbances such as ice scouring and wave action. Other natural factors that also regulate populations are temperature and salinity, sediment composition, and availability of organic material.

The primary impacts to the intertidal benthic habitats of routine operations related to oil exploration and production in the Beaufort Sea, Chukchi Sea, Hope Basin, and Norton Basin would result from subsea pipeline placement. Dredging of intertidal habitats for pipeline burial would disturb benthic communities at the site of the trench and include a corridor of up to approximately 9 m on either side. The intertidal dredging would be a small portion of the total bottom areas disturbed in the Beaufort Sea (95-120 ha) Chukchi Sea, Hope Basin (40-75 ha), and Norton Basin (20-40 ha) (Table 4-1b). The effects of pipeline burial would not be expected to impact benthic habitats beyond the first season after installation.

Pipeline landfalls (1 each in Chukchi and Hope Basin, 2 in the Beaufort Sea, 2-4 in Cook Inlet, and 1 in Norton Basin—Table 4-1b) may require construction of short causeways that would cover benthic habitats in the immediate area, resulting in loss of habitat. The presence of such causeways may also affect local currents and salinity that may, in turn, affect benthic invertebrate communities. The effects of causeways on currents and salinity would last for the life of the causeway. The impacts of buried pipelines and pipeline landfalls and related causeways to benthic communities in the Beaufort and Chukchi Seas would be localized and would be expected to be minor.

Unlike the arctic, the subarctic Cook Inlet Planning Area is characterized by high tidal differentials. In the northern Cook Inlet, the differences between high and low tide may be over 9 m, causing massive amounts of water exchange several times a day. Expansive mudflat areas are exposed in the northern part of Cook Inlet at low tide, while these mudflats are covered with water to the shoreline at high tide. In the western Cook Inlet, intertidal communities are affected by seasonal ice and show similarities to those found in the Bering and Beaufort Seas (Lees et al., 1986). This zone is dominated by polychaete worms and amphipods. In the western Cook Inlet, these communities are more closely related to those of southeast Alaska.

Oil produced from the lower Cook Inlet Planning Area would be transported from production platforms in the inlet to facilities at Nikiski on the Kenai Peninsula using subsea and overland pipelines.

Negative impacts to the intertidal benthic communities in the Cook Inlet Planning and Norton Basin Planning Areas resulting from routine operations related to oil exploration and production would be similar to those described for the arctic. Installation of pipelines would disturb benthic communities in localized areas near installation sites. This intertidal disturbance would be a small portion of the 30-95 total bottom disturbed in the Cook Inlet Planning Area (Table 4-1b). Such impacts would be expected to be minor. The displacement of coastal habitat by onshore pipelines, process facilities, and ice roads would result in minor impacts.

Accidents

Coastal wetlands and salt marshes could be affected by a large offshore spill (Table 4-1e) that reaches the shoreline or by a pipeline leak or other smaller spillage (Table 4-1e). For pipelines, small leaks would be expected to occur either at pipeline tie-ins or at the landfall. These will most likely be contained on the gravel pads. Leaks in the elevated portion of the pipeline could expose vegetation to oil. During winter, these spills will likely occur on top of snow and can be cleaned with minimal impacts to the vegetation. Spills during summer may penetrate the vegetative mat and kill the vegetation. In tundra habitats, oil will not penetrate the permafrost layer. The area would be cleaned and revegetated. Few spills have occurred on tundra during the development and operation of the Prudhoe Bay, Kuparuk, and Milne Point oil fields. Oil spills from pipelines are expected to be rare, limited to small areas, and quickly contained, and habitat would be restored. However, a large offshore spill that reaches coastal areas may have greater impacts, depending on the location and movement of the spill. Large spills that contacted key estuaries in the Beaufort and Chukchi Seas, Cook Inlet, or Gulf of Alaska would impact numerous organisms using these areas. Additionally, spill cleanup operations may also have impacts associated with trampling of vegetation in staging areas. Such impacts are expected to be minor to moderate, depending on the size and location of the spill.

In the Beaufort and Chukchi Seas, the most severe negative impacts of oil exploration and production to intertidal benthic habitats would be those involving an accidental oil spill from a pipeline or platform. A nearshore spill or an offshore spill that spreads to coastal areas by action of wind and currents could contaminate estuarine and coastal habitats. Contamination of these benthic habitats would result in the loss of biological productivity and diversity of oil-sensitive invertebrate communities. The effects could be long term in areas where oil is retained in sediments and could persist for 10 years or more. The negative impacts of oil contamination on benthic invertebrates may affect higher trophic-level species such as fishes and birds, especially shorebirds, that feed on benthic invertebrates. Depending on the size, location, and timing of the oil spill, negative impacts could be minor to moderate.

The most serious negative impacts related to oil exploration and production in the lower Cook Inlet would be those related to oil spills at production sites on platforms, or spills and/or leaks from pipelines. Oil from nearshore or offshore spills that spreads to coastal areas could contaminate benthic habitats. Areas outside the planning area, such as the Shelikof Strait and Katchemak Bay, located south of the Inlet, could be affected by oil that spreads to these areas by wind and/or currents. The extent of the negative impact would depend on the size and location of the oil spill, and the quantity and quality of the affected area. The effects could be long term, and habitats could require years to recover. This could have a secondary effect on higher trophic-level organisms such as birds and fishes that use these benthic habitats for feeding.

In the Gulf of Alaska Planning Area, the potential sources for oil spills includes spills that could occur during oil transport via tankers. An oil spill from a tanker could have the potential to contaminate intertidal benthic communities or other habitats outside the planning area as these vessels move along shipping channels to west coast ports. The extent of impacts would depend on the size and location of the oil spill and the quality and quantity of habitat affected. Negative impacts from an oil spill could range from minor to moderate.

Since only gas would be developed in the Norton and Hope Basins, oil spillage would be limited to the condensate part of the gas. This limited spillage would likely have no more than a minor impact on intertidal invertebrate communities and the coastal habitat in general.

The estimated probability of one or more large spills (500 bbl or greater) occurring from the proposed action is provided in Table 4-1e. The probabilities for such a large spill occurring are estimated as 34-40 percent (Cook Inlet), 92-98 percent (Beaufort Sea), and greater than 99.5 percent (Chukchi Sea).

Conclusion: Impacts to coastal habitats from the proposed action would be **minor** from routine operations. If large oil spills were to occur, they would likely result in **minor** to **moderate** impacts, the impact dependent on size and location of the spillage.

4.3.3.8. Seafloor Habitats

The Stefansson Sound Boulder Patch is a unique kelp-dominated community only occurring in the central portion of the Beaufort Sea Planning Area (Figure 3-29). The Boulder Patch community is considered vulnerable to potential effects from oil and gas leasing in the Beaufort Sea because of its extremely restricted distribution. Other subtidal benthic communities and habitats are also present in the Beaufort Sea, Cook Inlet, and Norton Sound, as described in Section 3.2.2.6.

Routine Operations

Routine operations that may impact the Boulder Patch and other seafloor habitats are pipeline burial and gravel island construction, which increase turbidity and sedimentation (see Table 4-1b). Increased water turbidity could directly affect kelp growth by altering the optical properties of the water column (Maffione, 2000), limiting photosynthesis. Dunton (1984) estimated that kelp was responsible for 50-56 percent of annual productivity in the Boulder Patch, depending on the turbidity of the ice cover. Kelp release particulate organic matter that supports various members of the epilithic community (Dunton, 1984). These organisms could be indirectly impacted by decreases in kelp productivity. Sedimentation could cause direct impacts to the Boulder Patch by burying kelps and other organisms. The impact level of turbidity and sedimentation on the Boulder Patch could range from negligible to moderate, depending on the actual location of any proposed development. It is estimated that two pipelines to shore would be constructed in the Beaufort Sea which could disturb about 95-120 ha of seafloor. Most construction activities would be completed in 1 to 2 years, at which time direct impacts would stop. The Boulder Patch would probably recover quickly from minor changes in turbidity and sedimentation. Moderate impacts would only occur if construction were to occur within the Boulder Patch community.

Drilling muds and cuttings, and produced waters associated with drilling activities would be discharged beyond 3 miles of the barrier islands offshore of the Boulder Patch. Any of these discharges reaching the Boulder Patch would be greatly diluted and would have negligible impact on the community.

Construction and maintenance of artificial islands, pipeline trenching, burial, and maintenance, and platform construction and maintenance have the potential to affect subtidal benthic communities. Benthic organisms at the site of construction will be destroyed. However, the total bottom area disturbed by pipeline and platform construction assumed under the proposed action is small (95-120 ha for pipelines and 18-36 ha for platforms—Table 4-1b) relative to the available habitat. The area of burial around constructed islands could increase over time by erosion from storm action and ice gouging on island slopes. For example, the U.S. Army Engineer District, Alaska (USAEDA, 1999) estimated the North Star project constructed island would eventually bury an additional 1.6 ha of soft bottom seafloor.

Organisms living in or on sediments adjacent to trenching operations may experience suffocation from burial, crushing from ice removal, and physiological stress from increased turbidity during trenching and backfilling activities. Stationary organisms such as clams and worms would be affected the most, although mobile isopods and amphipods could also be affected. The benthic community in these areas experiences similar naturally occurring disturbances from ice gouging, strudel scour, and severe storms. Colonization of the disturbed area would be expected within a few years (Woodward-Clyde Consultants, 1996). In Cook Inlet, similar impacts would be expected. However, invertebrates and marine plants requiring a hard substrate for settlement are expected to recolonize the area affected by platform construction within 1 or 2 years. The overall effects of platform construction would be to favor organisms requiring hard substrates, thus shifting community composition. Impacts to subtidal benthos are expected to be minor.

The water depth in most of the Norton Basin is about 20 m, so discharged drilling muds would be dispersed before sinking to the seafloor. Drill cuttings, however, would bury the benthic organisms within a few hectares for about a year. A pipeline between 25 and 55 miles in length may be laid to shore, disturbing the benthos in the pipeline corridor. The pipeline would be buried about 1.2 m down to avoid ice scour, so the width of the disturbed corridor might be 12.2 m resulting in a disturbed area of 20-40 ha. The overall level of impact of this action on Norton Basin seafloor and benthic communities would be measurable but minor.

Increased turbidity and sedimentation will also occur in habitat near construction activities. In general, turbidity plumes will not cause a reduction in species abundance beyond the range of natural variability or have adverse effects on the benthic biota. In the arctic, ice gouging and strudel scour cause similar bottom disturbances in the offshore zone, and hyposaline and highly turbid conditions occur naturally during spring breakup. Impacts from construction activities on seafloor benthic communities will be minor, and disturbed areas will probably be recolonized.

Production discharges include drilling muds, cuttings, and produced water. The discharge of drilling muds and cuttings creates plumes of material that rapidly disperse in the water column, becoming diluted by a factor of 10,000 within 1 to 3 hours of release (National Research Council, 1983a). In most continental shelf areas, most drilling muds and cuttings land on the seafloor within 1,000 m of the discharge point (USDOI, MMS, 1996d). The effects of drilling muds appear to be restricted to benthic organisms living in the immediate vicinity of and downcurrent from the discharge source. In general, organisms in larval and early juvenile stages are more sensitive than adults to these discharges. Sublethal responses of larvae and adults include alterations of behavior, chemosensory abilities, feeding, food assimilation, growth, efficiency, skeletal deposition, respiration and nitrogen excretion, and tissue enzyme activity (National Research Council, 1983a). Benthic organisms within 1,000 m of platforms and constructed islands would be expected to experience mostly sublethal effects, with some lethal effects on immature stages. However, the area that will be affected is a very small percentage of the available habitat. Recovery of the benthic communities in the affected areas would be expected to occur in 1 or 2 years (USDOI, MMS, 1996a; Woodward-Clyde Consultants, 1996). The overall impact level of operational discharges on benthic organisms will be minor.

Accidents

Oil spills contacting the Stefansson Sound Boulder Patch community could have direct impacts on organisms inhabiting the area. It is assumed that one pipeline spill (4,600 bbl) and one platform spill (1,500 bbl) could occur in the Beaufort Sea over the 35-year life of the proposal (see Table 4-1e). Oil can cause both lethal and sublethal effects to marine plants and invertebrates. Sublethal effects occur at lower concentrations and include reduced growth and/or fecundity, increased physiological stress, and behavioral changes. Sublethal effects may increase the probability of death from other environmental stress factors and lead to reductions in population size. Concentrations of oil less than 1 ppm produce a variety of negative effects in marine organisms. *Laminaria solidungula* found in the Stefansson Sound Boulder Patch has not been studied directly, but other *Laminaria* species from the Canadian Beaufort Sea showed marked physiological impairment when exposed to oils of several types and concentrations. In general, exposure to concentrations of 43 ppm caused a 25-percent reduction in photosynthesis, while 4,000 ppm reduced photosynthesis 45 to 60 percent (Hsiao et al., 1978). Shiels et al. (1973) reported inhibition of photosynthesis in *Laminaria saccharina* and two green algae species at 7 ppm.

Oil spills in the Beaufort Sea contacting the Boulder Patch would probably have short-term effects on kelp since the subtidal plants would, in most cases, not be coated by oil. Photosynthesis would probably be reduced from the floating oil, and this, if it persisted long enough, could impact growth and reproduction of the kelp. Benthic animal communities have been shown to have major shifts in species composition following exposure to oil. Such changes may alter food web dynamics. Changes occur when new species colonize an area following an oil spill that kills the local population, or when some species within the community are more resistant to the effects of oil. Most macroscopic benthic organisms inhabiting the Boulder Patch are longer lived, and shifts in species composition could last for extended periods if recruitment or recolonization by previously dominant species is inhibited.

The amount of oil that sinks to the bottom and the location of the oil spill in relation to the Boulder Patch would determine oil-spill impacts on the Boulder Patch community. If a large amount of oil were to sink and inundate the Boulder Patch, sensitive species could take 10 or more years to recover (USDOI, MMS, 1996a). However, in most instances, oil spills do not sink to the bottom but remain floating at the water surface. Even in the case of a leak or rupture in a buried pipeline, most of the oil would float to the surface. The benthic area directly contaminated by the leak would be expected to be within a 100-m radius of the leak or break in the pipeline (USAEDA, 1999). Unless a pipeline were routed directly through the Boulder Patch, impacts to this unique community from oil spills should be negligible to moderate, depending on the location and severity of the spill.

As with the Boulder Patch, other seafloor benthic communities are unlikely to be heavily oiled, even if spill volumes were large, since most of the oil would float. Sublethal impacts associated with low concentrations of oil in the water column would be expected in the immediate vicinity of the spill. Rupture or leakage from subsea pipelines would be expected to contaminate sediments within a 100-m radius of the leak or rupture (USAEDA, 1999). Organisms in those sediments would experience high levels of contamination and mortality. Impacts to other seafloor benthic communities from oil spills are expected to be minor.

Gas is the most likely type of hydrocarbon in Norton Basin and no oil spills are assumed under the proposed action. Although a spill of gas condensate could affect seafloor habitats, the condensate would probably be dispersed into the water column quickly, making any benthic effects very local and negligible.

Conclusion: Impacts to seafloor habitats and benthic communities from routine operations would be **minor** for most subtidal benthic communities. However, impacts due to turbidity and sedimentation on the Stefansson Sound Boulder Patch community could range from **negligible** to **moderate**, depending on the actual location of any proposed development. If a large spill were to occur and contact seafloor habitats and benthic communities, the impacts would be **minor** for most subtidal benthic communities. However, spill impacts on the Boulder Patch community could range from **negligible** to **moderate**, depending on size and location of the spill.

4.3.3.9. Areas of Special Concern

4.3.3.9.1. Essential Fish Habitat

Routine Operations

An explanation of EFH is in Appendix E**.** Routine operations from OCS activities that affect EFH are most likely to come from pipeline dredging, drilling, and surveying. Dredging activities can damage spawning habitat or juvenile rearing habitat, either by physically damaging them or by smothering them with suspended and redeposited sediment. Drilling muds and cuttings discharges that create turbidity and alter habitat (see Section 4.3.3.1.) are more likely to affect benthic species that spawn or rear offshore, whereas pipeline dredging may affect both benthic and offshore species as well as any species using inshore areas exposed to dredging. Structure placement will introduce a hard substrate that attracts opportunistic species and may result in new habitat for some prey species, which will attract some managed species.

Routine activities specific to arctic Alaska include gravel island construction and ice road construction. The gravel is mined from river bars. Water from local rivers and lakes is pumped onto the desired area to build a rigid surface. Both the removal of gravel and water will increase turbidity and reduce the water quality of EFH in the river.

Several managed fish species have part of their EFH designated areas in Cook Inlet and Shelikof Strait. Drilling and dredging can increase turbidity of the water column, and resulting sedimentation can smother benthic prey and change some of the bottom substrate. Some of the fish species whose EFH may be affected include walleye pollock, rockfishes, soles, Pacific halibut, Pacific ocean perch, Pacific cod, arrowtooth flounder, and sablefish. Species with EFH that can be damaged by dredging in nearshore areas include Pacific cod and salmon species.

Species with EFH in Norton Basin that can be damaged by deepwater drilling and dredging include king and snow crabs, Alaska plaice, Pacific cod, sculpin, walleye pollock, and yellowfin sole. Species with EFH in Norton Basin that can be damaged by dredging in nearshore areas include the 5 species of Pacific salmon.

Pipeline trenching and island construction could damage marine plants associated with EFH by mechanically removing the plants or smothering them through sedimentation. Pipeline trenching could disturb 95-120 ha of bottom area in the Beaufort Sea, 75-195 ha in the Chukchi Sea, 40-75 ha in Hope Basin, 30-95 ha in Cook Inlet, and 20-40 ha in Norton Basin. Bottom area disturbed as a result of platform installation would include 18-36 ha in the Beaufort Sea, 6-24 ha in the Chukchi Sea, 6 ha in Hope Basin, 4-12 ha in Cook Inlet, and 3 ha in Norton Basin.

Water quality of EFH could be degraded by increased turbidity from pipeline construction. The degradation is greater in shallow environments because of the MMS requirement for pipeline burial. The jetting or shoveling to create a trench for pipeline placement and burial will displace and resuspend sediments, increasing turbidity.

Discharges of drilling fluids and cuttings will temporarily increase turbidity and decrease EFH. Settlement of discharged cuttings on the seafloor will smother some prey species and change the substrate composition in the area where the cuttings settled. Discharges of cuttings per well include 4,070 bbl in the Beaufort Sea, 4,800 bbl in the Chukchi Sea, 2,460 bbl Hope Basin, 2,875 bbl in Cook Inlet, and 5,305 bbl in Norton Basin. Discharges of fluids per well include 545 bbl in the Beaufort Sea, 885 bbl in the Chukchi Sea, 550 bbl in Hope Basin, 655 bbl in Cook Inlet, and 945 bbl in Norton Basin.

Accidents

Spilled oil reaching the surface from the one assumed pipeline spill (4,600 bbl) in Cook Inlet as well as any oil from a spill related to tankering would have a short-term effect on surface water EFH. Many of the managed fish species have an epipelagic planktonic life stage so their EFH includes surface waters. Examples of these species include the larval stages of both the walleye pollock and the Pacific cod. These larvae can be found in the Gulf of Alaska from Dixon Entrance to 170^{o} W. longitude. Any larvae or planktonic prey species of managed fish species that comes into contact with the oil will be hurt or killed.

Accidents that affect EFH in Norton Basin are most likely to come from small spills of gas condensates. Such spills are not likely and, should they occur, are expected to be confined in Norton Sound near the pipeline or platform and rapidly disperse in the water and in the air. If a spill were to occur near the coastline, it is possible that salmon, particularly pink salmon which spawns intertidally, could be affected.

Accidents that affect EFH in the Beaufort and Chukchi Seas and Cook Inlet are most likely to come from oil spills that cause oil to wash inshore into wetlands, intertidal zones, rock and shorelines. These areas provide food and nursery habitat for juvenile fish and spawning areas for others such as the Atka mackerel, yellowfin sole, and all five species of Pacific salmon. Spilled oil reaching wetland habitat, including salt marshes, could kill vegetation and associated insect species and small fish that are prey species for salmon, thereby adversely affecting EFH. Spilled oil concentrated along the coastline at the mouths of streams or rivers may disrupt salmon species migration patterns.

Kelp and other marine plants are a component of salmon EFH, because they provide food and shelter for various life stages of a variety of potential prey in the Boulder Patch (habitat area of particular concern) and elsewhere in the Beaufort Sea. Spilled oil would smother the kelp and other marine plants that grow towards the surface, reducing habitat and settling substrate for potential prey of managed species.

Toxic fractions (PAH's) of spilled oil may contaminate benthic habitat as has been shown in the case of salmon eggs deposited in river bottoms in southern Alaska. The eggs were exposed to PAH's for 4 years following the 1989 *Exxon Valdez* oil spill (Murphy et al., 1999), despite the fact that spilled oil never reached the upstream nesting sites (most of the spilled oil settled in the delta region of the river). The oil is believed to have been transported upstream through interstitial spaces in the surface sediments.

Oil spilled under ice is more difficult to locate and clean than surface spills. Adult salmon in the Beaufort and Chukchi Seas would migrate away from the oil. Zooplankton are potential salmon prey, and they would be unable to move away from the oil. Since weathering will be greatly reduced by ice cover protection, these prey species will continue to be harmed or killed as they float into the trapped oil. These prey species could be subjected to short-term, localized reductions as a result. Sea ice is much more prevalent in the Chukchi and Beaufort Seas, rarely seen in Cook Inlet, and has not been documented in Shelikof Strait.

Conclusion: Potential impacts to EFH from routine operations under the proposed action are expected to be **minor**. If a large oil spill were to occur, impacts could be as severe as **moderate**, depending on the size, timing, and location of the spill.

4.3.3.9.2. National Parks, Refuges, and Forests

The following analyses use exploration, development, and transportation scenario assumptions for the proposed action in the affected Alaska Planning Areas. These assumptions are presented in Table 4-1b and Section 4.3.1. Assumptions used for oil spills are presented in Table 4-1e.

National Park System

Seven national parks, monuments, and preserves in Alaska are susceptible to impacts of OCS oil and gas development under the proposed action (Figures 3-31 and 3-32).

Routine Operations

Impacts from routine operations assumed under the proposed action would come from facilities developed to support offshore oil drilling and production, and could include effects from pipeline landfalls, dredging, air pollution, and the construction of roads and new facilities. Onshore oil facilities are permissible only on private acreage within each national park land. All seven of the national parks, monuments, and preserves of concern contain privately held acreage, but development of onshore oil support facilities is unlikely in many of these. The impacts of routine operations on these areas are discussed below.

- Oil transport through the Cape Krusenstern National Monument is permissible by the Alaska Native Claims Settlement Act of 1971 (ANCSA), and an existing road is in place that could be used to initiate development. However, the scenario associated with the proposed action would not be accommodated here. Thus, impacts, if any, from routine operations are expected to produce negligible impacts to this resource.

- The Lake Clark National Park and Preserve borders the Cook Inlet Planning Area. In addition, the park contains nearly 243,000 ha conveyed to Native organizations that are available for oil and gas facility development. Eight hundred of these hectares are on the north shore of Tuxedni Bay. Development of the facilities could impact air and water quality, damage coastal habitat, and fragment terrestrial and coastal habitat. However, since oil in the Cook Inlet Planning Area will be piped ashore to existing refineries at Nikiski, there would be no development of privately held lands in the park and preserve property. Impacts from the proposed action, if any, are expected to be negligible.
- The Wrangell-St. Elias National Park and Preserve is located adjacent to the Gulf of Alaska Planning Area. Since no offshore development is planned in this area, impacts, if any, from routine activities are expected to be negligible here.
- Onshore oil and gas development within park boundaries is considered to be unrealistic for the Bering Land Bridge National Preserve, Katmai National Park and Preserve, Glacier Bay National Park and Preserve, and Kenai Fjords National Park. Impacts, if any, from routine operations are expected to be negligible.

Accidents

Impacts from accidents assumed under the proposed action scenario would primarily be from oil spilled from onshore facilities, from offshore drill rigs or production platforms, or from transportation of oil. Oil spills would have the greatest effect on shoreline habitats and animal communities living in those areas. Impacts would depend primarily on the spill location, size, and time of year. In general, directly affected coastal fauna would include marine mammals; fishes that reproduce in, inhabit, or migrate through coastal areas; terrestrial mammals that feed on these fishes; and marsh birds and seabirds. Spilled oil could also affect subsistence harvests in those parks in which subsistence hunting and fishing are allowed, as described below.

- A majority of the Cape Krusenstern National Monument lies directly onshore from the proposed future exploration and development activities. However, only oil condensate may be accidentally released from gas activities in Hope Basin. Such a release is unlikely to have a substantive adverse effect on coastal fauna and subsistence hunting and fishing permitted within the national monument. Thus, the impact would be negligible.
- Oil spills could originate from either subsea transport pipelines or drill platforms in Cook Inlet, and could directly affect coastal fauna and subsistence hunting and fishing in or adjacent to the Lake Clark National Park and Preserve. Under such circumstances, impacts would range from minor to moderate.
- The Wrangell-St. Elias National Park and Preserve contains extensive reaches of shoreline adjacent to the Gulf of Alaska Planning Area, and could be contaminated by oil driven onshore from tanker spills in the Gulf of Alaska. Spilled oil would affect coastal fauna and could reduce the subsistence hunting and fishing that are permitted in the area. The potentially affected area includes the north shore of Yakutat Bay, an especially important wildlife habitat. Under such circumstances, impacts would range from minor to moderate.
- The Bering Land Bridge National Preserve contains shoreline on the northeast and northwest edge of the Seward Peninsula adjacent to the Hope Basin Planning Area. However, even an accidental oil condensate release in Hope Basin would only have a negligible impact on subsistence hunting and fishing permitted within the preserve.

- The Katmai National Park and Preserve contains extensive shoreline in proximity to Cook Inlet and the Shelikof Strait region. Spilled oil could originate from drill platforms or subsea transport pipelines from the proposed action in the Cook Inlet Planning Area. Tourism in the park is substantial and could be reduced by an oil spill. Under such circumstances, impacts would range from minor to moderate.
- The Glacier Bay National Park and Preserve lies just south of the Gulf of Alaska Planning Area and could be affected by oil spilled from tankers. Spilled oil would have negative affects on coastal fauna. Tourism in the park is substantial and could be reduced in areas contaminated by spilled oil. Under such circumstances, impacts would range from minor to moderate.
- Oil spills from the proposed action operations in the Cook Inlet Planning Area have a very limited potential to affect the Kenai Fjords National Park due to the park's isolated location. In the unlikely event that oil spilled in Cook Inlet would be transported towards the park, any oil washing ashore would impact coastal fauna and tourism. Under such circumstances, impacts would range from minor to moderate.

National Wildlife Refuges

Oil facility development is prohibited on the Arctic National Wildlife Refuge (ANWR) and is discretionary on all others. However, there are seven refuges that could potentially be affected by OCS oil and gas development from adjacent regions being evaluated per the proposed action (Figures 3-31 and 3-32). These refuges could be contaminated by oil spilled from offshore projects, or could be subject to negative effects from routine operations associated with the development of onshore oil and gas support facilities. Numerous refuge lands have been conveyed to private owners and Native corporations; Section 22(g) of ANCSA (1971) requires that new development on these lands must be in accordance with the purpose for which the refuge was formed. Development of onshore oil and gas support facilities is thus technically possible, but subject to intensive review.

Four refuges (Alaska Peninsula; Alaska Maritime; ANWR; and the Kodiak Refuge) may also contain subsea lands, which would prohibit OCS oil drilling within varying distance from the shoreline. These subsea lands are presently under review.

The specific effects and magnitude of routine operations and accidental events from the proposed action are essentially the same as discussed for the national park system, as noted previously. In addition, subsistence hunting and fishing are permitted on all refuges in Alaska and could therefore be affected by accidents and routine operations.

Routine Operations

- The Alaska Maritime National Wildlife Refuge, Chukchi Sea Unit, contains 97 ha available for development of onshore support facilities in the Chukchi Sea/Hope Basin Planning Areas under the proposed action. In the unlikely event that onshore oil and gas activities (pipeline landfall, storage and processing facilities) occur within the refuge, the impacts on this refuge are expected to be minor.
- The Alaska Maritime National Wildlife Refuge, Gulf of Alaska Unit, is open to development of onshore oil support facilities on a case-by-case basis, with acreage available for development near the Cook Inlet Planning Area. In the unlikely event of onshore oil or gas activity (oil or gas pipelines) within the refuge, the impacts on the refuge are expected to be minor.
- Since no OCS onshore or offshore activity occurs in the vicinity of the Alaska Peninsula National Wildlife Refuge, any impacts are expected to be negligible.

- Kodiak National Wildlife Refuge lies near the Cook Inlet Planning Area and contains about 191,000 ha that are privately conveyed and possibly available for development of onshore oil support facilities. However, since no routine activity from the proposed action is expected onshore or near this refuge, impacts, if any, would be negligible.
- For the Becharof National Wildlife Refuge; Alaska Maritime Wildlife Refuge, Alaska Peninsula Unit; and ANWR, no direct impacts from onshore routine operations are expected, given that they are closed to oil and gas facility development. Indirect impacts resulting from routine activities in adjacent areas, noise, or pollutant emissions associated with transportation of oil from the planning areas may occur, but impacts from routine operations are expected to be negligible.

Accidents

- The Alaska Maritime National Wildlife Refuge, Chukchi Sea Unit, is susceptible to oil spilled from tanker traffic and drilling platforms in the Chukchi Sea Planning Area. An oil spill would have detrimental effects on coastal fauna and subsistence hunting and fishing. Under such circumstances, impacts would range from minor to moderate.
- The Alaska Maritime National Wildlife Refuge, Gulf of Alaska Unit, is susceptible to oil spilled from tankers (Gulf of Alaska), offshore drilling platforms, and subsea pipelines (Cook Inlet). Oil spills that contaminated coastlines would be detrimental to coastal fauna, subsistence and commercial fishing, and tourism. Under such circumstances, impacts would range from minor to moderate.
- The Alaska Peninsula National Wildlife Refuge may be susceptible to oil spilled from offshore platforms and subsea pipelines (Cook Inlet). Spilled oil could have detrimental effects on coastal, terrestrial, and freshwater fauna and on subsistence hunting and fishing. Under such circumstances, impacts would range from minor to moderate.
- The Kodiak National Wildlife Refuge is susceptible to oil spilled from tankers (Gulf of Alaska), offshore drilling platforms and subsea pipelines (Cook Inlet). Oil spills that contaminated the coastline could affect coastal fauna, subsistence fishing, and commercial fishing for numerous species. Under such circumstances, impacts would range from minor to moderate.
- An extensive section of the Becharof National Wildlife Refuge is on the Shelikof Strait, just south of Cook Inlet. Oil contamination of this shoreline would affect coastal fauna, subsistence use, and nearby commercial fishing. Under such circumstances, impacts would range from minor to moderate.
- Some coastline of the Alaska Maritime Wildlife Refuge, Alaska Peninsula Unit, could be contaminated by oil spilled from tankers (Gulf of Alaska) or from drilling platforms and subsea pipelines in Cook Inlet. Oil contamination of this shoreline would affect coastal fauna, subsistence use, and commercial fishing. Under such circumstances, impacts would range from minor to moderate.
- The ANWR is considered to be most susceptible to oil spilled from subsea pipelines or drilling platforms in the Beaufort Sea. Oil contamination of this shoreline would affect coastal fauna and subsistence use. Under such circumstances, impacts would range from minor to moderate.

National Forests

Two national forests, Chugach National Forest and Tongass National Forest, are found in coastal Alaska (Figure 3-32).

Routine Operations

- The Chugach National Forest is susceptible to routine operations from the transport and tanker loading of oil produced in other regions, such as the Beaufort Sea Planning Area, and transported by pipeline to the Port of Valdez. Potential effects include increased noise and air pollution from tanker traffic, habitat loss due to facility and road development, and possible introduction of invasive organisms from jettisoned ballast water. Most effects are already ongoing from existing routine operations, but the development of new sites may extend the temporal or spatial scale of these effects. Impacts are considered to be minor.
- Since no onshore or offshore development will be occurring in the Tongass National Forest in the Gulf of Alaska, impacts, if any, are expected to be negligible.

Accidents

- The Chugach National Forest is susceptible to oil spilled from tankers and loading facilities at the Port of Valdez. Oil spills that reached the coastline would affect coastal fauna; subsistence, recreational, and commercial fishing; and tourism. Impacts would depend on the size and timing of a spill and would be expected to be minor to moderate**.**
- Shorelines within the Tongass National Forest are susceptible to contamination from oil spilled from tanker transport in the Gulf of Alaska. Oil spills that reached the coastline would affect coastal fauna; subsistence, recreational, and commercial fishing; and tourism. Impacts are expected to be minor.

The estimated probability of one or more large spills ($\geq$ 500 bbl) occurring from the proposed action is provided in Table 4-1e. The probabilities for such a large spill occurring are estimated as 34-40 percent (Cook Inlet), 92-98 percent (Beaufort Sea), and greater than 99.5 percent (Chukchi Sea). Smaller spills would be more numerous in the same planning areas (Table 4-1e).

Conclusion: Impacts from the proposed action's routine activities would be **negligible** for national parks (including monuments and reserves) and **negligible** to **minor** for national wildlife refuges and **negligible** to **minor** (**minor** for Chugach) for national forests. If large spills were to occur, impacts would be **negligible** to **moderate** for national parks, **minor** to **moderate** for national wildlife refuges, and **minor** to **moderate (**Chugach) for national forests.

4.3.3.10. Population, Employment, and Regional Income

4.3.3.10.1. Routine Operations

The primary potential direct effect of the proposed action on population, employment, and regional income will be generated by the expected routine OCS oil and gas activity. Most of the workers directly associated with OCS oil and gas activity will work offshore or onshore in worker enclaves separated from local communities. The exception is the Cook Inlet area including Anchorage and surrounding road-connected communities. Most OCS workers will likely commute to work sites from Alaska's larger population centers or from outside the immediate area. It is assumed that OCS jobs would be available to the local populations in all areas, but that rural Alaskan employment in the petroleum industry, especially among Native Americans, will remain relatively low.

In addition to direct OCS oil- and gas-related employment, indirect and induced employment will be generated in other sectors of the economy such as construction, transportation, and retail sales. The majority of indirect and induced employment will be located in Anchorage and other regional centers.

As explained in Section 4.3.2.11, MMS has generated estimates of population, employment, and regional income impacts from exploration and development scenarios for the program proposal and the other program alternatives. The model generating these estimates for the Alaska planning areas is conceptually consistent with the model used for the Gulf of Mexico.

The MMS estimates that the proposed action would increase Alaska State population by 6,000 to 13,000, average yearly employment by 3,000 to 7,000 jobs, and regional income by $101 million to $207 million in an average year.

Table 4-11 shows MMS's estimates of the impacts of the program proposal in each of the Alaska planning areas. The table identifies local impacts, impacts in the rest of Alaska, and impacts in the rest of the United States. All the estimates in the table consist of totals of the direct, indirect, and induced impacts. However, MMS also calculated the components for each of these estimates. For instance, the total of 2,600 employee years for the low-middle Beaufort Sea Planning Area scenario consists of about 2,200 direct employment, 300 indirect employment, and 100 induced employment in the NSB. For the same scenario in the rest of Alaska, a comparable breakdown would be 106,000 total, 72,000 direct, 17,000 indirect, and 16,000 induced. For the rest of the United States, it would be 119,000 total, 41,000 direct, 34,000 indirect, and 44,000 induced.

Workers at North Slope sites stay in enclave housing separate from local communities. For the most part, these employees live in south-central Alaska or the Fairbanks area and commute to their homes (or other locations) when not working. (South-central Alaska includes Anchorage, the Kenai Peninsula Borough, and the Matanuska-Susitna Borough.) Thus, the estimates of local employment and regional income associated with each planning area in Table 4-11 would occur in the planning area but would apply to employees whose permanent residences lie in other parts of the State or elsewhere. Because the overwhelming majority of workers will live elsewhere, MMS has not included estimates of population increases associated with each planning area.

Because most workers live elsewhere, employment in the North Slope petroleum industry has little direct impact on the communities of the NSB. However, the NSB receives other benefits from oil development. Revenue from taxation on oil industry facilities forms, by far, the most important component of the NSB tax base and provides the bulk of NSB revenue. The NSB will not be able to tax OCS offshore facilities; however, the NSB will collect some additional tax revenue from new onshore pipelines and other facilities. The NSB will also receive indirect benefits from Native corporation investments in petroleum service companies. Nevertheless, overall effects on the NSB and NSB communities are not likely to be significant, especially when combined with the continued decline in Prudhoe Bay production. Similarly, effects on Chukchi Sea/Hope Basin communities would be slight, due to the inability to tax most production facilities and little local employment. The proposed action includes 330 miles of onshore pipeline for the Chukchi Sea Planning Area. This pipeline would traverse the NSB from the shore of the Chukchi Sea to the TAPS. However, most of this land is federally owned (National Petroleum Reserve-Alaska), meaning the NSB would not be able to tax it.

Many workers on oil rigs in the Cook Inlet Planning Area (and onshore oil and gas facilities on the Kenai Peninsula and the North Slope) currently live in Anchorage or on the Kenai Peninsula. The larger populations and more diverse economies of south-central Alaska compared to other Alaskan communities will tend to dampen the impact of additional leasing on their economies. As a result, employment generated by OCS activity in the Cook Inlet Planning Area at its peak is only expected to account for between 1 and 5 percent of total south-central Alaska employment for 2 to 5 years; furthermore, no sector of the regional labor force will change by more than 10 percent.

Although the probability of successful development in Norton Basin is low, should development occur, some impact may be felt in Nome, which would be the likely base for marine and air support. However, as is true for the North Slope, the majority of impact will fall on other parts of Alaska, mostly south-central Alaska.

4.3.3.10.2. Accidents

An oil spill could occur in any sale area, and cleanup-related employment would likely also occur in the affected area, generally in locations remote from communities. The hiring of cleanup workers would have a regional and State of Alaska emphasis. The regional assessment of the potential impacts of OCS oil and gas development is based on the history of petroleum development in Alaska (1970 to the present).

Oils spills will generate only temporary employment (and population) increases during cleanup operations, because such operations are expected to be of short duration. Employment generated by spills will be a function of the size and frequency of spills. "Small spills" are included in the discussion of routine operations, and for the most part would have minor effects. "Large" spills of over 1,000 bbl would generate 250 to 500 jobs for up to 1 month, and 15 regional center monitoring jobs for 1 year, and would generate moderate local effects. With the exception of Norton Basin and Hope Basin, each Alaskan planning area is assumed to experience one spill of up to 4,600 bbl. Impacts from oil spills on population, employment, and regional income are expected to be minor.

Conclusion: Potential impacts on population, employment, and regional income from routine operations and oil spills are expected to be **minor** except for **moderate** local impacts from a large oil spill.

4.3.3.11. Land Use and Existing Infrastructure

The largest concentration of oil and gas activity within the State of Alaska is located on the North Slope around the Prudhoe Bay complex. While the Prudhoe Bay field comprises the bulk of current Alaskan production and is in decline, the North Slope remains a prolific oil-producing province containing untapped fields. The Kenai Peninsula and Cook Inlet comprise the other area of oil and gas production in the State of Alaska. Petroleum production dates from the 1970's on the North Slope, and the 1950's on the Kenai Peninsula.

Due to its size, geography, and relative isolation, the settlement pattern and transportation history of Alaska as a territory and State has been strongly affected by water and air carriers. Alaska's biggest growth and development spurt occurred at the same time as that of the aircraft industry. After World War II, Alaska was left with a great number of airstrips capable of handling large aircraft. After the discovery of oil, additional airstrips were constructed so that virtually all Alaskan communities are accessible by some sort of aircraft. Alaska's road network is relatively small for its size, and of relatively recent origin. Southcentral Alaska and the Kenai Peninsula possess the densest road networks in the State, and are connected to Fairbanks and Canada (and the lower 48 States) by highways as well. The Dalton Highway, a gravel road from Fairbanks to Deadhorse/Prudhoe Bay, connects the North Slope to this road network, and in recent years has been opened to the public (although it does not provide public access to the Arctic Ocean). The Alaska Railroad runs from Seward on the Kenai Peninsula to Fairbanks. Most of Alaska's coastal communities have some form of docking facilities, and there are a number of natural deepwater ports. Some of the principal developed deepwater ports are Ketchikan, Valdez, Seward, Whittier, Kodiak, and Unalaska. Regionally important ports exist at Nome, Kotzebue, and Prudhoe Bay, but only shallow-draft barges can use these facilities. Nikiski has some developed tanker-loading facilities. Yakutat Bay has a deepwater port, but is relatively undeveloped.

Routine Operations

Routine petroleum operations have created ports, airfields, extensive pipelines and service roads, and petroleum processing and handling facilities. The proposed action would expand existing land-use infrastructure and transportation systems by the construction of support bases, terminals, airfields, pipelines, and roads.

Routine operations in proposed petroleum exploration, development, and production include the construction of petroleum industry infrastructure. Associated expansion of existing transportation systems in response to the increased needs of the petroleum industry, and the movement of personnel and materials (both for construction as well as produced hydrocarbons) will occur. The main components of these construction-related activities have been summarized in Section 3.2.3.2. Construction-related activities are discussed by region below, in terms of effects on air transportation, effects on ports and vessel transport, and effects on surface transportation.

Routine operations associated with the proposed action could significantly affect land use in the Beaufort Sea and Chukchi Sea/Hope Basin subregions by building pipelines (subsea and overland), service roads, and new or expanded marine-support facilities, petroleum processing facilities, and airfields. While the Prudhoe Bay complex can provide logistical support for Beaufort Sea OCS exploration and development, no such facilities currently exist for the Chukchi Sea/Hope Basin subregions. Kotzebue or one or more uninhabited locales are the probable sites for such facilities. Subsea pipelines would be constructed from OCS developments for up to three landfalls in the Chukchi Sea/Hope Basin subregion, and one new landfall in the Beaufort Sea subregion. It is probable that at least minimal petroleum processing facilities will be required at these locations. Oil production from the Chukchi Sea/Hope Basin subregions would be shipped via a newly constructed overland pipeline to the TAPS at Prudhoe Bay. The overland pipeline system would thus be extended into a totally new area, along with the increased access provided by service roads or airstrip facilities. This could permanently alter the area's land-use patterns, especially if a road were to be constructed along the pipeline route. Given present development trends, new road construction would likely be minimized, which would also minimize potential effects. Some new pipelines would also be required in the Beaufort Sea subregion, but probably in a developed area. Thus, the community of Kotzebue, the uninhabited areas around the Chukchi Sea/Hope Basin subregion landfalls, and the pipeline route from the Chukchi Sea landfalls to TAPS will experience the greatest changes in land use. Such changes will cause at least moderate effects, and could be major due to the construction/expansion of ports, airfields, and other exploration-development-production facilities, and the potential for increased access.

Anticipated pipeline (subsea) construction activities could affect approximately 125-160 miles in the Beaufort Sea subregion, 100-260 miles in the Chukchi Sea, and 50-100 miles in Hope Basin subregions. In addition, the latter would also entail an overland connection to the TAPS, or a shorter pipeline to tanker-loading facilities in or offshore from Hope Basin production. Some additional Beaufort Sea subregion onshore pipelines will also be required, but of shorter length and possibly within current pipeline right-of-ways. Crude oil handling (and possibly storage and/or processing) facilities would need to be constructed at one landfall in the Chukchi Sea subregion, one in the Hope Basin subregion, and two landfalls in the Beaufort Sea subregion. Airfields could be constructed near at least one of the Chukchi Sea/Hope Basin landfalls, or could entail the expansion of existing community airstrips (Wainwright or Point Lay). Airstrips would also be located next to the pump stations and work camps located along the routes of onshore pipelines constructed as a result of the proposed action (especially that connecting the Chukchi Sea region to TAPS).

It is likely that petroleum-related warehouse and transitory dormitory facilities will be needed at Kotzebue, as a regional center. Shallow-draft dock facilities will also need to be constructed at a minimum of one of the Chukchi Sea subregion landfalls, and expanded in or near Kotzebue. Tanker shipments from Valdez would not be expected to increase due to additional arctic OCS production, due to the continued decline in arctic onshore production. Arctic OCS production will only offset part of this expected overall decline in production. Surface-transportation effects would be centered on those created by the construction of roads associated with pipelines. Current practice is to minimize the use of surface roads.

The infrastructure and logistics required to support a single offshore drilling platform and a small diameter pipeline are not expected to significantly effect either the infrastructure or land-use patterns of the Nome area. Anticipated pipeline construction activities could affect approximately 20-40 miles in the Norton Basin Planning Area. A small support base would be constructed adjacent to a pipeline/pier jetty. This jetty would facilitate the shoreline entry of the small diameter pipeline. Dependent on developmental economics, a small refinery/liquefaction plant would be located next to the support base. Refined hydrocarbons would then be loaded to barges or truck tankers for transport within the region or consumed locally. Excess production would be stored. Depending on formation structure, production of a gas prone field could be significantly slowed over the winter season without damaging the hydrocarbon reservoir. Transportation to and from the platform could be accomplished from a heliport located at the airport or at the support base.

Routine operations associated with the proposed action could significantly affect land use in the Cook Inlet. The community of Nikiski in the Cook Inlet has some existing oil and gas support facilities. However, additional elements would be needed. Cook Inlet OCS production could be transported via a newly subsea constructed pipeline to the tanker-loading facility near Nikiski. However, both loading and storage capabilities would require expansion to handle the increased volume of produced crude oil. Such land-use changes would be expected to have moderate effects on other user groups and resources (i.e., subsistence, sociocultural systems).

Anticipated pipeline (subsea) construction activities would include approximately 30-95 miles in the Cook Inlet region. The Cook Inlet pipelines would probably connect to a landfall at existing crude-processing and tanker-loading facilities (increased refining capability for local use in Alaska may take place). Direct air service to Nikiski/Kenai may also need to be expanded, but because of road connections to Anchorage, most transportation needs associated with the proposed action can currently be accommodated. These facilities have the potential for moderate effects on coastal communities, primarily through potential effects on subsistence and other alternative resource uses.

Accidents

One significant land-use effect prompted by oil spills projected under the proposed action would be the exposure of new areas of Alaska (i.e., Chukchi Sea/Hope Basin) to the potential effects of crude oil spills, and the requirement to maintain more extensive crude-oil-spill response equipment in those areas. Oil-spill effects on biological and socioeconomic resources are discussed in other sections of this analysis. Oil-spill response equipment will be maintained in conjunction with other industry support facilities. Impacts of oil spills on land use are expected to be minor.

One significant effect expected under the proposed action would be the construction of petroleum industry facilities in, and increased access to, “new” areas of Alaska (i.e., Chukchi Sea and Hope

Basin). This will significantly expand the area potentially at risk from the possible effects of oil spills, along with the requirement to maintain oil spill response equipment in those areas. Continued OCS development in the Beaufort Sea and Cook Inlet subregions would increase the potential effects of spills in those areas. Impacts of accidents on infrastructure and transportation networks are expected to be moderate.

Conclusion: Potential impacts on land use and existing infrastructure due to routine operations under the proposed action are expected to be **moderate** for both arctic and subarctic areas. Potential impacts on land use and existing infrastructure due to accidents under the proposed action would range from **minor** to **moderate**.

4.3.3.12. Fisheries

Relevant Alaska fisheries have been described in Section 3.2.3.3. Potential effects on commercial fisheries will be discussed in this section. Such effects are best addressed on a regional or community level. Potential sportfishing effects are discussed in the recreation/tourism section (Section 4.3.3.13), and potential subsistence fisheries effects are discussed under sociocultural systems (Section 4.3.3.14).

Routine Operations

The single commercial fishery in the Beaufort Sea is for cisco and whitefish on the Colville River during the summer and fall months. Potential effects upon that operation would be directly due to effects on the fish resource and would be negligible or minor. There are no commercial fisheries in the Chukchi Sea other than a relatively small chum salmon fishery in Kotzebue Sound. The OCS development and production activities could have minor impacts on this fishery.

Virtually all commercial harvesting of salmon, herring, and other species of finfish in Norton Basin occur in the rivers and tributaries or in coastal waters less than 3 miles from shore. Consequently, the only potential for conflict between petroleum-industry activities and commercial fishing activities would be that associated with pipelines. However, pipelines are likely to be buried in all waters of 30 m in depth or less, thereby removing most of the area of potential conflict. Furthermore, the principal types of gear used for the harvesting of finfish in this region (gill nets and seines) are unlikely to suffer damage due to contact with unburied pipelines. Hence, the effects of pipelines on commercial fishing are expected to be very low.

The likelihood of conflicts between fishing vessels in Norton Basin and a petroleum industry vessel or a petroleum production platform is also very low. A high percentage of the winter commercial crab harvest is taken at locations within 3 miles of shore and through the ice. However, since oil and gas activities are expected to occur further than 3 miles from shore, the effects of gear loss, loss of ocean-fishing space, and loss resulting from drilling and related activities would be very low. The summer fishery for red king crab is an offshore fishery within Norton Basin. Hence, oil- and gas-related activities could interfere with this fishery by causing fishing gear loss, loss of ocean fishing space, fishing-vessel collisions, and negative effects from drilling and related activities. However, because of the low level of oil and gas activity expected, such occurrences are expected to be very infrequent.

Significant fisheries take place in subarctic regions in Cook Inlet and the Gulf of Alaska. The most significant Cook Inlet fishery is salmon, predominantly sockeye harvested with drift and set gillnets. Halibut, tanner crab, and shrimp are also part of the Cook Inlet fishery complex. The Yakutat fishery is also predominantly a salmon fishery, with the addition of sablefish, halibut, and a limited amount of pollock. Gulf of Alaska fisheries significant for other communities are pollock, cod, and rockfish, along with salmon, halibut, and sablefish. Crab and shrimp have been significant in the past, but stocks are low at the present time.

Potential effects of the proposal on commercial fishing in Cook Inlet include:

- effects of discharges from OCS operations;
- loss of ocean area occupied or disturbed by exploration rigs, production platforms, or pipelines, resulting in a possible loss of harvest;
- gear conflicts and entanglement, resulting in damage to or loss of fishing gear, and lost fishing time;
- loss or damage to fishing vessels through collisions with oil industry vessels and equipment;
- conflicts with seismic survey vessels;
- competition for support services, infrastructure, materials, onshore space, and labor; and
- small oil spills.

Drilling discharges and offshore construction in Cook Inlet associated with the proposal are expected to be negligible, due to the small area likely to be affected. Competition effects are likely if OCS development were to occur. No routine exploration and development activities will occur in the Gulf of Alaska because no sales are proposed in that planning area. Therefore, there will be no conflicts with commercial fishing.

Loss of harvest in Cook Inlet due to foreclosure of fishing areas by offshore facilities would be minimal because of the small area occupied by platforms and pipelines. Longline gear conflict is also possible, but could be minimized through a program of mutual communication of activities and avoidance. Such a program would also minimize the potential for longline and pot conflicts with marine seismic surveys. The Oil/Fishermen's Group, formed in the 1980's, and the Manual for Geophysical Operations in Fishing Areas of Alaska (developed jointly by the commercial fishing and oil industries) are components of such a system.

Competition for services and labor would occur largely during exploration and development, given the generally limited marine support services available and the intensive and concentrated nature expected of such OCS activity. This could result in additional costs to the fishing industry for the duration of OCS exploration and development, although once production began, such competition would be reduced (either due to reduced OCS demand or increased supply). Competition for services and labor also would occur during oil-spill response incidents, which is discussed in the section below. Impacts of routine operations are expected to be minor.

Accidents

The occurrence of a tanker spill near commercial fishing areas while fishing is open could have significant effects for Gulf of Alaska fisheries. Under the proposed action, one 7,800-bbl tanker spill is assumed to occur (Table 4-1e). Such a spill could foul gear and potentially close some fishing grounds. A large spill is likely to increase competition on alternative fishing grounds that remain open, resulting in increased costs and/or reduced harvests for individual fishermen. There is a smaller chance of a spill occurring during a pulse fishery of short duration, such as salmon or herring, because of the relatively short period of time that such fisheries are open. However, if a spill were to occur during such a fishery, the effects would likely be more significant because such fisheries are typically among the most lucrative for the fisherman, and would likely result in a total loss due to the inability to switch to an alternative fishing time or area.

The best estimates of the effects of a large oil spill are from the 1989 *Exxon Valdez* oil-spill incident, which were estimated to range between $6.4 and $41.8 million in 1989 and $11.1 and $44.5 million in 1990 (an average of $9-43 million per year). However, the largest spill posited under the proposal is a 7,800-bbl tanker spill; that is a tiny percentage of the size of the *Exxon Valdez* spill. Depending on which estimates one accepts, the effect of the *Exxon Valdez* oil spill could range between a 5-percent loss and a 57-percent loss in ex-vessel value of the harvest for 2 years. Based on the *Exxon Valdez* oil-spill experience, compensation to the commercial fishing industry for participating in the cleanup of such an oil spill is likely to exceed these economic losses. The effects of a 7,800-bbl tanker spill from the proposed action could be expected to be much smaller, and more local in nature, although the magnitude of effects is not clear. On the individual level, of course, some fishermen would fare better than others, but those not participating in the cleanup and without fishing alternatives to disrupted fisheries may experience severe losses.

Oil spills typically result in the closure of fishing grounds and reduced harvest. Even if harvest continues, the perception of a tainted product can reduce the economic value of fish harvested after an oil spill. The short, intense, local economic spurt often induced by spill response efforts could result in a temporary increase in the cost of support and logistical services due to competition.

Conclusion: Potential impacts on commercial fisheries from routine operations under the proposal would range from **negligible** to **minor**. If a tanker spill were to occur in the Gulf of Alaska during fishing season, **minor** to **moderate** impacts to commercial fishing could occur in the Gulf of Alaska. Effects on Bering Sea commercial fisheries would be **negligible**.

4.3.3.13. Tourism and Recreation

Recreation and tourism activities along the Alaskan coast consist primarily of water dependent activities, such as fishing, boating, sightseeing, and associated land-based activities, such as hiking, picnicking, hunting/gathering, and camping. Most of these activities are water oriented because of the remoteness and undeveloped nature of much of Alaska's coast. Access is in many places restricted to aircraft (floatplane or short-strip wheeled plane) or boat. The remoteness, wilderness character, and scenic quality of the setting are key attractions of these activities. The same characteristics also tend to limit the number of people (resident and tourist) who can participate in them, although at the same time, due to space and time constraints, the perception of overcrowding can be a problem. Access to inland recreational opportunities along the coast is most often quite limited.

Routine Operations

The arctic region has a number of national parks and national wildlife refuges, as described previously. Because of their remoteness and the absence of organized tours, relatively few tourists visit these areas. There are organized tours, by air, to regional hubs such as Barrow, Prudhoe Bay/Deadhorse, and Kotzebue. Such tours typically allow visitors a visit of a few hours to a number of days in one or two of these locations. The North Slope tour offers the opportunity to fly one way and take a bus trip on the Dalton Highway the other, so that visitors also have a chance to see what that part of Alaska (and the Prudhoe Bay complex and the pipeline) looks like. Some unguided visitors (as well as North Slope residents) also take advantage of the Dalton Highway for access. Both guided and unguided hunters use aircraft to access various parts of the region, primarily inland.

Routine OCS activities would have only minor effects on these activities, and may promote some tour activity. The Dalton Highway was constructed to support petroleum development on the North Slope, but it is now a State road; thus, it would be available for future tourism and recreation activities regardless of proposed OCS activities.

Given the limited development in the Norton Basin area (Table 4-1b), it is unlikely that any sites having recreational or tourism values will be affected. In contrast, most of the potential effects of routine OCS activities on tourism and recreation in Alaska will be felt in the Cook Inlet area. This area is closest to Alaska's centers of population, and has the most developed commercial tourist industry. Anchorage is located at the head of Cook Inlet. The area west of Cook Inlet is roadless. Much of the west coast of the Kenai Peninsula (the east shore of Cook Inlet) is accessible by a road that connects a series of various-sized communities. These communities, in turn, are access points for water-based and land-based activities. The road system notwithstanding, much of the Kenai Peninsula is relatively undisturbed, with abundant scenery and wildlife. Changes in visual quality would be expected to be local and would be concentrated in periods of high industry activity, such as drilling and laying pipe. The proposed action would add new platforms to those that currently exist in Cook Inlet. Any closure of areas to water-oriented recreational activities would be only for short periods of time. Additional population, crowding, or competition effects due to the proposed OCS activities would be possible, because much of the population and employment increases would occur in the Anchorage/Kenai Peninsula area. Given the relatively small magnitude of these changes in relation to the overall population and economy of that area, however, these effects are expected to be minor.

Accidents

Oil spills have a great potential to disrupt tourism and recreation in all subregions of Alaska. This reality was demonstrated by the *Exxon Valdez* oil spill. The *perception* of environmental effect by the target (paying) customer base was as, or perhaps even more, important for this effect than was the actual environmental effect of the spill. After the *Exxon Valdez* oil spill, tourism in Prince William Sound was markedly reduced and took several years to recover. Likewise, the public perception of recovery (or lack of recovery) from the effects of the spill was critically important to the tourism industry.

Oil spills have the potential to affect large areas in Cook Inlet and the Gulf of Alaska. The risk of a spill in the Gulf of Alaska stems from OCS arctic oil which has passed through the TAPS and is being tankered from Valdez to the lower 48 States. In Cook Inlet, an oil spill could foul the beaches on the west side of the Kenai Peninsula and disrupt fishing, sightseeing, and camping for as much as a full season. Many urban Alaskans, as well as visitors from other States, make use of these opportunities and facilities; thus, oil-spill effects in Cook Inlet must be assessed as at least moderate. The pristine character of scenic resources along the Alaskan Peninsula may also be affected for a season by a large spill, but effects would be minor because the area is so undeveloped. The same evaluation of minor impacts applies to most of the Gulf of Alaska. Public perception, and a generalization of effects from one area to another, could increase the significance of spill event effects beyond their "objective evaluations," as is discussed briefly above with respect to the *Exxon Valdez* oil spill.

Conclusion: Potential impacts on tourism and recreation from routine operations and large oil spills are expected to range from **minor** to **moderate**.

4.3.3.14. Sociocultural Systems (including Subsistence)

Subsistence activities are extremely important in all parts of rural Alaska and, combined with kinship comprise the fundamental idiom for describing Native (and some non-Native) social organization and culture. This relationship has been described in Section 3.2.3.5. Diverse subsistence activities take place in all Alaska coastal regions potentially affected by the proposed action. Fish and marine mammals are the resources of most concern, as they constitute a large part of the harvest and typically are the resources most likely to be directly affected by OCS activities. Waterfowl are also a resource of potential concern. Land mammals are also important subsistence resources, but are potentially affected more indirectly by transportation pipelines and other support infrastructure and services than by direct OCS oil and gas activities. Cook Inlet is a somewhat limited and special case, due to the complicated nature of the dual State-Federal management of subsistence in Alaska and the division of State and Federal management responsibilities in the region (Section 3.2.3.5). The State manages all salmon fisheries, and there is a relative lack of subsistence opportunities in Cook Inlet due to State regulation and management. State Cook Inlet subsistence fisheries are important for Tyonek, on the west shore of Cook Inlet, and Port Graham and Nanwalek on the extreme southern portion of the Kenai Peninsula. Under Federal authority, limited sea mammal harvest and subsistence halibut (and some other non-salmon species) fishing can take place in Cook Inlet. Oil spills have historically resulted in significant effects upon subsistence resources and subsistence activities, but routine OCS operations could also potentially result in significant effects. Such potential effects of routine operations will be discussed on a regional basis, followed by the discussion of oil spill (accident) effects.

Routine Operations

Potential "sociocultural systems" effects are somewhat difficult to discuss in the abstract. At the State level, it is not likely that routine petroleum activities arising from the proposed action would have major effects. While it will contribute to the overall State economy and pattern of slow growth, and the petroleum industry is a primary driver of the State economy, the incremental effects of OCS development resulting from the proposed action would be very difficult to disentangle from other ongoing dynamics. Regional and, where appropriate, community-specific discussions are likely to be more fruitful. Because some specific potential effects are the focus of separate sections (e.g., economics and demography, subsistence, fisheries, recreation and tourism), they are only treated in general in this topical analysis as they relate to more general concerns.

Rural and urban Alaska alike are somewhat dependent upon the State of Alaska for the provision of services, such as for funding public education. Organized rural boroughs, such as the NSB, partially support public education throughout the State by taxing the oil industry. This tax allows the State to be a significant supporter of the educational system throughout rural and urban Alaska. State troopers and Village Public Safety Officers are sometimes the only law enforcement in rural communities. The State also provides important health and other benefits (as does the Federal Government). Thus OCS activities can be expected to have effects on Alaskan communities, and especially rural communities, through various State programs. These effects would be proportionate to the percentage of the State budget that is composed of revenues from OCS oil and gas production, which for the period of this planning document will be relatively small.

For the arctic region, the potential direct and indirect effects of routine OCS operations derive from noise, visual, and traffic disturbances as a result of offshore operations, and disturbances from the construction and operation of pipelines and other shore-based facilities. Noise and traffic disturbances may result from seismic activities; the construction, operation, and decommissioning of drilling facilities; supply and tankering operations; and construction, operation, and decommissioning of production facilities. Visual disturbance (of resources and/or subsistence users) may be perceived to result from the mere presence of offshore rigs or other facilities.

Local residents have consistently indicated that whales and other marine mammals are very sensitive to noise, and have been disturbed from their normal patterns of behavior by past seismic and drilling activities. They can also become less predictable and more dangerous to those who hunt them. Whalers from Nuiqsut and Kaktovik have been especially vocal on this issue, as they are most likely to be directly affected by such activities during the fall open-water season. Fenton Rexford (Kaktovik) stated that during exploratory drilling in Canadian offshore waters (to the east of Kaktovik, and where whales come from during their fall migration when Kaktovik whalers hunt them) ". . . we were not successful or had a very hard time in catching our whale when there was activity with the SSDC [single steel drilling caisson], the drilling rig off Canada. And it diverted [bowhead whales] way offshore; made it difficult for our whalers to get our quota" (testimony cited in USDOI, MMS, 1996d). Herman Aishanna reported that in 1985, the SSDC affected Kaktovik whaling even though it was idle—"We got no whales that year" (USDOI, MMS, 2001). Burton Rexford related his experience of the effect of seismic activities on whaling in 1979-1981: "There were three of us captains that went out whaling in the fall. In those three years we didn't see one bowhead whale, and we saw no gray whales, no beluga, and no bearded seal (McCartney, 1995, cited in USDOI, MMS, 1996d). Tom Albert, the non-Inupiat senior scientist for the NSB, related that "When a captain came in to talk to me, I knew he was going to say that the whales are displaced [by noise] farther than you scientists think they are. But some of them would also talk about 'spookiness'; when the whales were displaced out there and when the whaler would get near them, they were harder to approach and harder to catch" (USDOI, MMS, 1997b). An entire session devoted to whaling captains' observations on the effects of noise on whales and whaling can be found in USDOI, MMS (1997b).

That marine mammals are sensitive to noise disturbance is clear, although thresholds in terms of signal characteristics and distance for each species have not been established. Generally, such effects would be localized to the vicinity of the seismic vessel, the construction site, or the drilling/production unit, and to the actual time of operation. Lease stipulations for whaler/oil industry conflict resolution and other "nondisturbance" agreements have minimized such problems in the recent past. (e.g., Northstar Lease Stipulations, MMS Whale Feeding Study Agreement). Nevertheless, issues persist with concern to "skittish" behavior of the whales due to noise disturbance, in turn making them more dangerous to hunt.

Past industry activities have been effectively limited in specified areas during critical periods of subsistence use through industry/subsistence-user cooperation. The potential disturbance effects of production operations may be more difficult to mitigate, as such activities will by definition be longer term and operate year-round. Further, the need to install additional platforms in the Beaufort Sea (beyond those already in development or planning), and platforms in the Chukchi Sea, over a period of 35 to 40 years, could increase the areas and times where either industry or subsistence activities are restricted. This would increase the possibility for significant harvest disruption. This would be further exacerbated if construction and production activities were concentrated in critical subsistence-use areas rather than dispersed. Potential cumulative effects of multiple projects are discussed in a separate section.

Routine petroleum industry activities generally do not interfere with subsistence fishing, which occurs in fresh water or near shore. Effects would be confined to potential reductions in fish populations (or health effects), which have been evaluated in the fishery resources discussion (Sections 3.2.2.4 and 4.3.3.6).

Offshore pipeline effects on subsistence will generally be confined to the period of construction and will be mitigated through lease stipulations, which will minimize industry activities during critical subsistence-use periods. Onshore pipeline effects on subsistence would occur during the 1- or 2-year construction period, and for the operational life of the pipeline. The major onshore pipeline constructed for the proposed action would connect Chukchi Sea oil production with the TAPS. It would cross a large area that is currently undeveloped, except for isolated and relatively small airstrips in various conditions. The potential effects of the pipeline on subsistence resource use patterns, while unavoidable, can be at least partially mitigated and minimized with proper pipeline design and location/routing. Potential effects of a pipeline on subsistence users (perceptions of areas they wish to avoid, or which are difficult for them to access for hunting and/or trapping) can be addressed with design considerations (for instance, by elevating or burying at least segments of the pipeline) and by including subsistence users in the consultation process. The most difficult potential onshore pipeline effects to mitigate would be those related to pipeline servicing and access. If a service road were constructed for this purpose, it would greatly increase access to subsistence resources on the western part of the North Slope. This effect would be greater if such a road were eventually opened to public access, on the model of the Dalton Highway. Roads are also reported to impose substantial maintenance costs on subsistence equipment (snow machines and sleds) and to present some safety issues (Impact Assessment, Inc., 1990a). Current practices are to minimize the construction of new roads. If pipeline servicing was conducted using aircraft, and perhaps ice roads or other ground transport in winter, such potential access effects would be minimized. Increased aircraft traffic in the summer could have a moderate effect on subsistence uses, but with subsistence-user coordination, these effects may be reduced.

Effects on the sociocultural systems and subsistence harvest patterns of communities in the Norton Basin Planning Area could occur as a result of changes in population and employment and potential effects on subsistence-harvest patterns due to disturbance from industrial activities (seismic activity; helicopter and supply vessel traffic; noise from construction and operation of exploration and delineation wells, a production platform, and a 25-55 mile gas pipeline), and a potential gas condensate spill.

Potential effects to population and employment from exploration and development of gas resources in the Norton Basin are expected to be minor. These minor impacts could be further mitigated by housing oil workers in an enclave. Effects from exploration and development seismic activity, supply traffic, and construction disturbance could temporarily disturb and displace some marine mammals, and marine and coastal birds but are expected to be short term and local and not affect population distributions or abundance in the Norton Basin. Because of very low effects expected on population and employment and subsistence resources, negligible effects would be expected on the social organization, cultural values, and social health of communities in the Norton Basin region.

The potential effect of pipelines upon subsistence resources themselves (in terms of population and behavior) are discussed in the wildlife section (Biological Environment; Section 3.2.2). Specifically in regard to caribou, this section concludes that onshore facilities and activities associated with the proposed offshore development program in northern Alaska should have temporary impacts on individual caribou but negligible effects on caribou herds. Negative impacts to caribou can continue to be minimized by mitigation measures, including:

- construction of pipelines at least 100 m from roads;
- elevation of the pipelines greater than 1.5 m above the ground;
- maintenance of traffic control in critical areas such as calving grounds in season;
- installation of buried or higher than normal pipelines in areas that are typically traveled heavily by caribou; and

- adherence to minimum altitude levels for aircraft in flight.

At one level, it could be argued that the principal sociocultural systems effects of the proposed action in arctic Alaska will be in the areas of subsistence, with implications for health, population, and the economy. All of these topics, except for health, are discussed in other sections. At another level, this analysis would be remiss if it did not again draw attention to the unique combination of benefits and costs that petroleum development has fostered in arctic Alaska, and especially on the North Slope, primarily through the NSB and various Native organizations. The more general agents of change, of course, are the increased availability of monetary resources, the Alaskan/American political system, and the American/world system of free exchange. In other arctic Alaskan areas without petroleum development but with other resources, such as the Northwest Arctic Borough, the same dynamics are present, although at a much reduced scope. The potential for OCS activity, and the proposed program in particular, will contribute to the continuation of these trends. Much of the regional sociocultural effects of OCS activities will be indirect or induced as the result of State programs, as most OCS population and economic effects will not be directly evident at the regional level. Rather, they will be most evident at the State and large population center levels.

At the same time, it is critically important to recognize that social systems and cultures are seldom, if ever, stable. Culture is learned from one's teachers (parents, relatives, etc.), which tends to be an influence for continuity, and personal experience with an environment that is often different from that of one's teachers, which tends to be an influence for adaptation and change. Thus, many of the items on any list of sociocultural concerns should also be analyzed in the context of adaptive change. Changes in some categories of behavior do not necessarily reflect changes in cultural values. For instance, smaller household size may be a measure of the fragmentation of "traditional" social organization. However, it is more likely a reflection of the increased availability of housing, exposure to the model of the "American nuclear family," increased local wage labor opportunities, better health care and support services for older people living independently, and other factors. What is often perceived as the "erosion of cultural values" is often only a transformation or changes in the behavioral expression of that value (modes of sharing, expressions of respect). On the other hand, it must also be recognized that some behavioral changes are more significant of cultural and value change than others. That is perhaps why public testimony on the effects of petroleum development in arctic Alaska (and especially that of Native Elders) has focused on subsistence and the relationship of people to the land and its resources, health, increased social pathologies, and the use (and loss) of Native languages. While the OCS activity of the proposed action will only contribute incrementally to these effects, it is vitally important to recognize that they will occur within this context.

Some of the vectors of sociocultural change that have been commonly noted in studies of arctic Alaska (Klausner and Foulks, 1982; Kruse et al., 1983a,b; Galginaitis et al., 1984; Luton, 1985; Worl and Smythe, 1986; Kevin Waring Associates, 1988a; Chance, 1989; Impact Assessment, Inc., 1989a, b; Jorgensen, 1990; Human Relations Area Files, 1992), lease sale documents (USDOI, MMS, 1990b, 1996a, 1998b, 2001), or testimony during the lease sale process (numerous USDOI documents, 1978 to the present time) can be briefly summarized as follows:

- Changes in community and family organization (availability of wage labor opportunities locally or regionally, ethnic composition, factionalism, household size);
- Institutional dislocation and continuity (introduction of new institutions, "loss" or de-emphasis of older or more traditional ones, and adaptation of new forms to old content or values, and vice versa);
- Changes in the pattern of overall subsistence activity (time allocation, equipment and monetary needs) and the potential disruption of subsistence harvest activities by industrial development (discussed under Section 3.2.3.5 on Subsistence);

- Changes in health measures, which are a combination of increased access to health care, changes in diet, increased exposure to disease, substance use and abuse, concern over possible exposure to contaminants of various sorts, and perhaps other factors;
- Perceived erosion of cultural values and accompanying behaviors (increased social pathologies such as substance abuse, suicide, and crime/delinquency in general; decreased fluency in Native languages; decreased respect for Elders; less sharing); and
- Cultural "revitalization" efforts such as dance groups, Native language programs, and official and regular traditional celebrations (such as the reestablishment of Kiviaq, or the Messenger Feast, in the NSB).

While these are all in some sense generalizations and "analytical constructs," all are also supported by specific testimony of Native residents of the region. These dynamics are not generally viewed as oil and gas (let alone OCS) development specific, but rather as the overall context within which Inupiat culture must continue to exist.

As discussed in Section 3.2.3.5, subsistence activities in Cook Inlet itself are quite limited, because of its proximity to Anchorage and classification by the State as a nonsubsistence area. State salmon subsistence fisheries are conducted near the Native communities of Tyonek, Port Graham, and Nanwalek. Federal subsistence regulations apply only to fishes other than salmon, Dolly Varden, trout, grayling, char, and burbot. Rainbow trout and steelhead trout may be retained if caught incidentally in other subsistence fisheries, but may not be targeted (Federal Subsistence Board, 1999). A Federal subsistence fishery for halibut has recently been established, with a bag limit of 20 fish. This fishery will be affected only to the extent that the resource population is affected. Thus, the routine operations proposed by the proposed action would have negligible to minor effects on these activities. Alaskan Natives can hunt marine mammals under the Marine Mammal Protection Act (MMPA). Beluga are the most significant subsistence resource taken from Cook Inlet, and their population has experienced a sharp decline in the recent past. Routine industry activities have not been found to contribute significantly to this decline, and the effects of increased routine industry activity on beluga populations are assessed in section 4.3.3.3.1 of this analysis. The current subsistence harvest of Cook Inlet beluga is limited to one animal, for the village of Tyonek, per year. The actions proposed should have negligible effects upon this harvest. Routine activities associated with the proposed action that occur on land will take place for the most part on State or private land (western Kenai Peninsula). They will thus not greatly affect subsistence activities on Federal land, except as they affect resource populations that use both Federal and State lands. The assessment of such potential effects, and what mitigation measures would be possible, is a nest of very complicated analytical and political issues.

These areas have already experienced the effects of oil and gas development, and would also experience both the positive and negative effects of increased population and employment from the proposed action's OCS activities. Most communities are ethnically diverse, with Caucasian majority populations. Native communities tend to be more remote and more difficult to access than do non-Native communities, and they would be somewhat buffered from the proposed actions effects. Overall, impacts of routine operations on sociocultural systems are expected to be minor.

Accidents

Oil spills are probably the most significant potential source of adverse effects attributable to the proposed action. Negative effects to specific subsistence species, as well as to the more general patterns of subsistence resource use, persisted in Prince William Sound for several years after the 1989 *Exxon Valdez* oil-spill event and the subsequent cleanup effort. The *Exxon Valdez* oil-spill event demonstrated that a very large spill could affect Prince William Sound as well as the east coast of the Kenai Peninsula and the beaches of the Kodiak/Shelikof Strait area. However, the *Exxon Valdez* event was 75 times as large as the spills posited as part of the proposed scenario (Table 4.1e—Large Oil-Spill Assumptions). A pipeline spill in Cook Inlet could affect subsistence activities on the Kenai Peninsula, Kodiak Island, and the Alaska Peninsula. Such effects would reduce the availability and/or accessibility of subsistence resources, typically for a single season or less, but potentially for longer periods. Resources subject to such effects include those that are most significant for the area, fish and shellfish as well as marine mammals and, to some extent, terrestrial mammals. Birds and marine plants would also be resources at risk that are used locally.

The effect of both large and small spills are expected to be significant in the Chukchi/Beaufort Seas subregions. An oil spill of more than 1,000 bbl could, depending on the time and location of the spill event, affect the subsistence use of marine mammals in the region where it occurs. Marine mammals are the most important subsistence resource, both conceptually as well as in terms of food, for these regions. The bowhead whale hunt could be disrupted, as could the more general and longer hunt for walrus (west of Barrow) and other marine mammals generally. Animals could be directly oiled, or oil could become part of the ice floes they use on their northern migration. Such animals may be undesirable, and may be more difficult to hunt because of the physical conditions. Animals are also likely to be "spooked" and/or wary, either because of the spill itself or because of the "hazing" of marine mammals, which is a standard spill response technique in order to encourage them to leave the area affected by the spill. There has been little experience with under-ice or broken-ice oil spills, and local residents have little confidence in industry's current capability to successfully clean them up in a timely manner. As Mayor George Ahmaogak stated at the Bowhead Whale subsistence Hunt and OCS Oil and Gas Activities: A Research Design Workshop, "I do not believe oil spills can be dealt with in ice infested waters. The industries test have failed, and anti whaling groups will use this to increase protest against bowhead whaling. It is a threat to our way of life." (April 5 and 6, 2001). While the concern is most typically phrased in terms of the potential effects of oil spills on whales and whaling, it can be generalized to a concern for marine mammals and ocean resources in general. Marine mammals and fishes typically comprise 60 percent of a coastal community's diet, and the ocean is frequently referred to in public testimony as "the Inupiat garden." Pipeline and platform spills could also affect migrating anadromous fishes in the river deltas, as well as species that use oiled coastal and nearshore habitat (nesting birds, breeding caribou). Overall, the impacts of oil spills on subsistence are variable, ranging from minor to major, dependent on the size, location, and timing of the spill.

Effects from a gas condensate spill in the Norton Basin region on subsistence resources—marine mammals, marine and coastal birds, and fish—are expected to be local and temporary and would not affect the abundance and distribution of these resources. Compared to a potential spill at a Yukon delta community from routine fuel supply barge traffic, the risk and potential effects from a gas condensate spill would be lower. Because very low effects (short-term and local) are expected on subsistence resources, negligible effects would be expected and no disruption of traditional practices for harvesting, sharing, and processing subsistence resources are expected to occur in communities in the Norton Basin region.

The sociocultural effects of oil spills are of at least two types. The first is the result of direct effects upon resources that are used in some way by local residents (i.e., subsistence, tourism, recreation, and elements of quality of life). The second is the effects of the spill cleanup efforts, in terms of short-term increases in population and economic opportunities, as well as increased demand on community services and increased stress for individuals. As is evident from the *Exxon Valdez* oil-spill event, such cleanup efforts can be quite disruptive socially, psychologically, and economically for an extended period of time. While the magnitude of effects decline rapidly in the year or two after a large spill, long-term effects are also evident (Palinkas et al., 1993; Picou, 1992, 1996). Such effects can be mitigated, and one important element in such a program is the establishment of, and local participation in, an effective spill response effort formulated into an explicit spill response plan. Such local programs can be credited as one effect of spill events, and do have a number of benefits. They provide local employment, a sense of local empowerment, and a means for local resident/oil industry communication.

Conclusion: Potential direct and indirect impacts of the proposed action on sociocultural systems due to noise, visual, and traffic disturbances as a result of offshore operations for the proposed action are expected to be **minor**. Potential direct and indirect impacts on sociocultural systems due to routine operations of offshore pipelines for the proposed action will be **minor**. Such effects due to onshore pipelines will be **minor** to **moderate**, and are dependent on mitigation and consultative measures. Potential impacts on sociocultural systems from routine operations under the proposed action would be **minor** to **moderate**, with less significant effects expected in areas already experiencing oil and gas development (i.e. Cook Inlet). Potential impacts on sociocultural systems from accidents under the proposed action could range from **minor** to **major**, depending on the size, location, and timing of a spill.

4.3.3.15. Environmental Justice

Executive Order 12898 on environmental justice for minority and low-income populations was issued in 1994. It specifies that "… each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations" (59 FR 7629). This analysis is to explicitly include effects on patterns of subsistence resource use in this treatment of human health or environmental effects (Council on Environmental Quality, 1997). Mitigation measures should be developed to address all identified effects. Agencies must incorporate effective public participation and consultation in this process, and provide full access to information. Such measures are to be integrated into the level of National Environmental Policy Act (NEPA) review required (e.g., finding of no significant impact [FONSI], environmental assessment [EA], environmental impact statement [EIS]), and are to recognize the government-to-government relationship between Federal and tribal governments.

By definition, OCS activities take place primarily offshore (with onshore support activities) and thus most directly affect coastal communities. Most Alaskan coastal communities are rural and predominantly Native (minority), and many contain at least subpopulations with low incomes. That is, any OCS activity in Alaska is likely to significantly affect a specific local minority (and possibly poor) population. The OCS activity in Cook Inlet may be a possible exception, due to the proximity of Anchorage (and about half of the State's total population), but, even for Cook Inlet, several small communities meet the Executive Order 12898 qualifications for consideration under environmental justice considerations. A general case could, thus, be made that any effect arising from Alaskan OCS activity is liable to have environmental justice implications.

For these reasons, the MMS socioeconomics studies agenda has emphasized the documentation of subsistence use, and the potential effects of OCS activities on such uses, along with the more general characterization of rural (Native and non-Native) social organization and the incorporation of local and traditional knowledge. A series of comprehensive studies has focused most heavily on North Slope communities (the area of most onshore and offshore oil and gas activity) and in Prince William Sound (the site of the most extensive oil-spill and cleanup effort in Alaska). In addition, MMS has funded projects to synthesize local and traditional knowledge in these two geographical areas, specifically oriented towards the *Exxon Valdez* oil-spill event for Prince William Sound The section discussing "sociocultural systems" and "subsistence" are relevant in this regard (see section 4.3.3.14).

Tables 3-25 through 3-30 provide information sufficient to characterize the coastal regions adjacent to Alaska OCS Planning Areas in terms of ethnic composition and income and poverty measurements. Regional measures are compared with those for the State as a whole to determine whether a region has a disproportionate minority population, or a larger than average population with incomes below the poverty line. The analysis of potential impacts arising from the proposed action is then examined in view of this information, and conclusions on potential disproportionate adverse effects upon minority populations and populations in poverty are presented.

For Alaska as a State, minority ("non-White") populations constituted about 26 percent of the population in 1998. American Natives made up about 17 percent of the total population, African Americans about 4 percent, and Asian/Pacific Islanders about 5 percent. About 9 percent of the 1990 population was below the poverty line, and mean income was $54,200 (median income was $46,581). All of the regions considered in this document, except for southcentral Alaska (Anchorage and the Kenai Peninsula), have significantly larger minority populations than the State as a whole. This is one component of the "urban-rural" divide between the Anchorage area and much of the rest of Alaska. The NSB is 69-percent "minority," with 56 percent of the total population being Native American, 11 percent Asian/Pacific Islander, and 2 percent African American. Northwest Alaska is 85 percent "minority," with 84 percent of the total population being Native American. For southcentral Alaska, "minorities" constitute only about 20 percent of the population, and only 8 percent of the total population is Native American, with the rest split between African Americans and Asian/Pacific Islanders. The communities of Tyonek, Port Graham, and Nanwalek in southcentral Alaska are predominantly Native communities. Thus, any effects from the proposed action for northwest Alaska and the NSB, or the communities of Tyonek, Port Graham, and Nanwalek in southcentral Alaska will disproportionately affect minority populations.

In terms of poverty of these regions, only northwest Alaska, has a disproportionate percentage of its population below the poverty line. However, the community of Tyonek has a very large population in poverty, and Yakutat's is somewhat larger than the State average. In terms of income, northwest Alaska is again the lowest of these regions and significantly below the State median. Southcentral Alaska is somewhat below the State income median, with the community of Tyonek being very much below the state median. Median income for the NSB is actually higher than for the State as a whole, but analysis of the two most recent NSB population surveys demonstrates that non-Inupiat households have significantly higher incomes than do Inupiat households, and that a good number of Inupiat households are living below the poverty line (Harcharek, 1995; Shepro and Maas, 1999). Thus, any effects from the proposed action for northwest Alaska, the NSB, or Tyonek in southcentral Alaska will disproportionately affect populations living in poverty.

The central issue of effects on subsistence will be used as a proxy or constructed for this potential complex of effects, and will serve as the basis for a discussion of possible mitigation measures. The NSB Municipal Code defines subsistence as "an activity performed in support of the basic beliefs and nutritional need of the residents of the borough and includes hunting, whaling, fishing, trapping, camping, food gathering, and other traditional and cultural activities" (State of Alaska, Department of Natural Resources, 1997). While this is at best a partial view of the significance of these activities to the Inupiat (and more generally to Alaskan Natives) as individuals and culturally, it stresses subsistence as a primary cultural and nutritional set of activities upon which Alaskan Natives depend (see Section 3.2.3.5).

Disproportionately adverse effects on Alaskan Natives could result from the proposed activities in all regions, although in southcentral Alaska such effects would most likely be concentrated in Tyonek. Such effects could be direct, indirect, and cumulative. Oil spills, as discussed in section 4.3.3.14, would add an additional component to such effects.

Inevitably, "perceptions of risk" exist among local residents concerned about accidents or new developments projects in general. They consist of "Not In My Backyard" responses to the proposed action manifest in fear and concern for their cultural rights and resources. Considering the importance of social networks that are maintained through subsistence cultural patterns, any type of disruption adds to cumulative change. The mere fact that, for example, certain NSB members engage in actively opposing offshore development, and encourage other community people to do so as well, cumulates perspectives of social change.

Mitigation of potential effects on subsistence activities will involve the protection of biological resources, the orientation of oil and gas personnel to the environmental and cultural concerns of local residents, and extensive consultation with local residents to avoid disruption of their activities. Again, USDOI, MMS (2001) discusses these measures in some detail for the NSB.

Conclusion**:** Alaska Native populations are present in many coastal areas of Alaska. It is possible that new onshore infrastructure could be located near these populations and produce adverse health or environmental impacts if there are effects on subsistence foods and/or harvest patterns. In the case of an oil spill, it is also possible that the potential environmental and health impacts on Alaska Native populations could be disproportionately high and adverse depending on the geographical location of the spill and the effects this may have on subsistence resources. Mitigation measures should be developed in order to reduce potential impacts before they occur. Mitigation will not eliminate disproportionately high and adverse impacts; however, it will reduce them.

4.3.3.16. Archaeological Resources

Archaeological resources in the Alaska Region that may be impacted by the proposed action include historic shipwrecks or aircraft, inundated prehistoric sites offshore, and historic and prehistoric sites onshore. Archaeological sites along the present shoreline, in shallow nearshore waters and along shallow bathymetric highs, have a high likelihood of having already been severely impacted by ice gouging. Shipwrecks in deeper water, beyond the areas of severe ice gouging such as in the deeper waters off Point Barrow, have a chance of survival. Likewise, prehistoric archaeological sites that have been buried by a sufficient amount of sediment may be protected from the effects of ice gouging, winter storms, and current scour.

Routine Operations

Routine activities associated with the proposal that are likely to affect archaeological resources include drilling wells, platform installation, and pipeline installation, as well as onshore facility and pipeline construction projects that involve ground disturbance. While the source of potential impact will vary with the specific location and nature of the routine operation, the goal of archaeological resource management remains the protection and/or retrieval of unique information contained in intact archaeological deposits.

Regulations at 30 CFR 250.194 allow the MMS Regional Director to require that an archaeological report based on geophysical data be prepared if there are indications that a significant archaeological resource may exist within a lease area. For historic resources, this decision is based on whether a historic shipwreck is reported to exist within or adjacent to a lease area. For prehistoric resources, an analysis is completed prior to each lease sale that considers the relative sea-level history, the depth of burial of the late Wisconsin land surface, the type and thickness of sediments burying the old land surface, and the severity of ice gouging at the present seafloor. Lease areas that are shown by this analysis to have the potential for prehistoric archaeological resources are required to have an archaeological survey prior to initiating exploration and development activities. If the survey finds evidence of a possible archaeological resource within the lease area, the lessee must either move the proposed activity to avoid the possible resource or conduct further investigations to determine if an archaeological resource actually exists at the location. If an archaeological resource is present at the location of proposed activity and cannot be avoided, the MMS procedures require consultation with the State Historic Preservation Office to develop mitigating measures prior to any exploration or development. It is assumed for this analysis that the level of protection provided by the regulation is in place.

Federal, State, and local laws and ordinances, including the National Historic Preservation Act, the Archaeological Resources Protection Act, and the Alaska Historic Preservation Act, protect known sites and also as-yet-unidentified archaeological resources. Existing regulations require archaeological surveys to be conducted prior to permitting any activity that might disturb a significant archaeological site. Therefore, most archaeological resources will be located, evaluated, and mitigated prior to any onshore construction. New data related to the human history and prehistory of Alaska likely will be produced from compliance-related archaeological projects associated with the proposal.

Accidents

Oil spills and their subsequent cleanup could impact the archaeological resources of the Alaska Region directly and/or indirectly. The geologic history of specific shorelines generally affects the presence, absence, condition, and age of archaeological sites on or near Alaska Region shorelines. However, some type of archaeological resource is present on or adjacent to nearly all Alaska Region shorelines. Archaeological resources are particularly abundant along Gulf of Alaska shorelines (Mobley et al., 1990).

Archaeological resource protection during an oil spill requires specific knowledge of the resource's location, condition, nature, and extent prior to impact. However, large portions of the Alaska Region coastline have not been systematically surveyed for archaeological sites. While some response groups have compiled known archaeological site data in a form useful for mitigation during an emergency response (Wooley et al., 1997), these data have not been compiled for all areas of the Alaska Region. Subarea plans for the North Slope, Cook Inlet, and Prince William Sound reference procedures for addressing and mitigating potential impacts to archaeological resources should an oil spill occur (Alaska Regional Response Team, 2000).

Gross crude oil contamination of shorelines is a potential direct impact that may affect archaeological site recognition. Heavy oiling conditions (Whitney, 1994) could conceal intertidal sites that may not be recognized until they are inadvertently damaged during cleanup. Crude oil may also contaminate organic material used in ^{14}C dating, and, although there are methods for cleaning contaminated ^{14}C samples, greater expense is incurred (Dekin et al., 1993). However, many other anthropogenic sources of hydrocarbons and other possible contaminants also exist, so caution should always be taken when analyzing radiocarbon samples from coastal Alaska (see Reger et al., 1992). A study examining the effects of the 1989 *Exxon Valdez* oil spill on archaeological deposits revealed that oil in the intertidal zone had not penetrated the subsoil, apparently due to hydrostatic pressure (Dekin et al., 1993).

The major source of potential impact from oil spills resulting from the proposed action (Table 4-1e) is the harm that could result from unmonitored shoreline cleanup activities. Cleanup activities could impact beached shipwrecks, or shipwrecks in shallow waters, and coastal historic and prehistoric archeological sites. Unmonitored booming, cleanup activities involving vehicle and foot traffic, mechanized cleanup involving heavy equipment, and high pressure washing on or near archaeological sites pose risks to the resource. Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with effective training and supervision. As Bittner (1993) described in her summary of the 1989 *Exxon Valdez* oil spill: "Damage assessment revealed no contamination of the sites by oil, but considerable damage resulted from vandalism associated with cleanup activities, and lesser amounts were caused by the cleanup process itself."

Interagency and regulatory aspects of oil-spill archaeological site protection have recently been clarified. A programmatic agreement (Regional Response Team, 1997) specifies the Federal On-Scene Coordinator's (FOSC's) role in protecting archaeological resources, the type of expertise needed for site protection, and the appropriate process for identifying and protecting archaeological sites during an emergency response. Under the agreement, the FOSC's Historic Properties Specialist coordinates and directs the site identification and protection program, with consultation and cooperation of the Unified Command and other affected and interested parties.

Conclusion: Assuming compliance with existing Federal, State, and local archaeological regulations and policies, most impacts to archaeological resources resulting from routine activities under the proposal will be avoided. Therefore, only a **minor** level of impacts to archaeological resources are anticipated from routine operations. Based on the scenario for the proposal, some impact may occur to coastal historic and prehistoric archaeological resources from accidental oil spills. Although it is not possible to predict the precise numbers or types of sites that would be affected, contact with archaeological sites would probably be unavoidable and the resulting loss of information would be irretrievable. The magnitude of the impact would depend on the significance and uniqueness of the information lost, but based on experience gained from the *Exxon Valdez* oil spill, the impact would most likely be **minor** to **moderate**.

4.3.4. Pacific Region

4.3.4.1. Water Quality

Routine Operations

Routine tanker operations assumed for the proposed action that could potentially affect marine and coastal water quality include operational discharges and wastes. Coastal and offshore water quality off the coasts of Washington and Oregon is very good, while marine and coastal water quality along the northern California coast is generally excellent. Coastal and marine water quality off southern California is generally good, but, as with the central California coast, localized areas of water quality degradation exist due to high volume point sources (e.g., municipal wastewater outfalls in Los Angeles, Orange County, and San Diego), coupled with the combined effects of discharges from numerous small sources. Treated effluents from transiting tankers would be rapidly diluted and dispersed. In contrast to stationary (fixed or floating anchored) production systems and their associated discharges in the Gulf of Mexico and Alaska Regions, tanker discharges in the Pacific Region will occur while the vessel is in transit, facilitating dispersion. As a result, only extremely localized and short-lived water quality degradation will occur while the tanker is in transit. Dilution and dispersion will act quickly to return water quality to normal. Compliance with existing discharge regulations (e.g., U.S. Coast Guard, MARPOL) is expected, and diminished water quality would quickly recover without mitigation. The impacts from routine operational discharges from the proposed action would be minor.

Accidents

Under the proposed action, the accidental release of 7,800 bbl of crude oil (see Table 4-1e) along the deepwater tankering route off the U.S. west coast is assumed. Impacts to water quality from a spill of this size would be variable and of short duration. The severity of impact will depend upon the exposure of the spilled oil to currents, wind, and turbulence. Degradation of water quality from hydrocarbon contamination arising from a large spill may occur, but will vary in space and time depending upon area-specific decomposition and weathering processes. In addition, most oil components are not soluble in water. Oil tends to float and undergo weathering at the sea surface. A tanker spill of this size could introduce minor concentrations of oil (e.g., water soluble fractions) into the water column, but this would not measurably degrade water quality except in the immediate vicinity of the spill source. Water quality impacts from a tanker spill would be minor.

Conclusion: Overall marine water quality impacts due to routine tanker operations associated with the proposed action would be **minor**. An accidental tanker spill in deep water of the Pacific Region will affect water quality in a localized area, and the impact would be unavoidable. However, because the resource would recover without mitigation, impacts from an accidental tanker spill would be **minor**.

4.3.4.2. Air Quality

4.3.4.2.1. Routine Operations

The engines powering the tankers carrying crude oil from Valdez to west coast ports would emit NO_x, SO_2, PM_{10}, and CO, with NO_x being the largest emission source. The emissions would have a negligible impact to air quality on shore because of the distance from shore and because emissions are spread over a distance due to the ship's motion. Unloading of crude oil in port would also result in emissions from the engines used in driving the pumps, and there would be fugitive VOC emissions. Emissions of NO_x and VOC have the potential to contribute to ozone formation under favorable meteorological conditions. These emissions are important in the San Francisco Bay and Los Angeles areas, which experience ozone levels that exceed the Federal standard. Potential impacts from tankers would be mitigated by the applicable local emission control requirements, which would normally include the use of VOC emission control measures when the vessel is unloading crude oil. The contribution from the tankers to total emissions in the port area would be very small. The air quality impacts from tankers operating in the ports would be minor.

4.3.4.2.2. Accidents

Small accidental oil spills would cause small, localized increases in concentrations of VOC due to evaporation of the spill. Most of the emissions would occur within a few hours of the spill. After that period, emissions would be significantly reduced. Large spills would result in emissions over a large area and a longer period of time. A discussion of the effects of oil spills on air quality is presented in Section 4.3.2.2.

In situ burning of a spill would result in emissions of NO_2, SO_2, CO, and PM_{10} and would generate a plume of black smoke. A discussion of the effects of in situ burning is presented in Section 4.3.2.2.

Studies of in situ burn experiments have shown that air quality impacts are localized and short-lived and that pollutant concentrations do not pose a health hazard to persons in the vicinity.

In summary, any air quality impacts from oil spills would be localized and of short duration. Emissions do not appear to be hazardous to human health. The impacts from in situ burning are also very temporary. Pollutant concentrations would be expected to be within the NAAQS. The air quality impacts from oil spills and in situ burning would, therefore, be minor.

Conclusions: The air quality impacts from routine operations associated with the proposed 5-year program would be **minor**. Air quality impacts from accidental spills would be **minor**.

4.3.4.3. Marine Mammals

4.3.4.3.1. Cetaceans

There are six listed cetacean species that may occur in waters of the Pacific Region, including the blue, fin, humpback, northern right, sei, and sperm whales. Detailed descriptions for these species have been provided in Sections 3.2.2.1 and 3.3.2.1. More than two dozen nonlisted cetacean species may frequent waters of the Pacific Region, including gray whales, killer whales, beaked whales, pilot whales, pygmy sperm whales, dolphins, and porpoises Several species are present either year-round (e.g., resident killer whales) or seasonally (e.g., gray whales).

Routine Operations

The proposed action and basic scenario assumptions are covered in Sections 2.1 and 4.3.1 respectively. Because there are no sales proposed for the Pacific Region, the only "routine" activity occurring there will be tanker traffic associated with the transport of Alaska OCS oil. An estimate of the total annual number of tanker transits through the Pacific Region under the proposed action is not presently known. Impacts associated with tankers include discharges (bilge and waste discharges), collisions, and noise. It is assumed that all discharges would occur in accordance with acceptable operating standards (e.g., U.S. Coast Guard requirements, MARPOL guidelines). Tankering operations will produce limited amounts of operational wastes. Discharges will occur while tankers are in transit offshore in deep water. Based on the low concentrations of discharged contaminants within an open ocean environment and the short-term duration of these discharges (i.e., tanker in transit), tanker discharges will mix rapidly with ambient seawater and will be quickly diluted. Impacts to cetacean species from tanker discharges would be negligible.

Tanker traffic may result in vessel strikes (collisions with cetaceans). All of the listed cetacean species of the Pacific Region can be found within oceanic waters, including shipping lanes. Therefore, there is the possibility that listed species may encounter a tanker in transit. However, tankers produce considerable noise, and cetacean species are expected to recognize that a tanker is approaching and initiate appropriate avoidance behavior, minimizing the potential for collision. Routine tanker traffic is expected to occur along transit corridors that are far removed from shore, the preferred migratory routes of gray whales and killer whale habitat. In the event that killer whales or other nonlisted cetaceans may be present in proximity to a tanker, only minor behavioral reactions would be expected (e.g., turning away, abrupt diving). Some other nonlisted cetaceans (dolphins, porpoise) are fast swimmers and are known to ride the bow wave of transiting vessels. Therefore, impacts of tanker traffic and the associated potential for collisions to cetaceans are negligible.

Sources of tanker noise are those low frequency sounds created by the propulsion system and ancillary systems (e.g., electrical generation, pumps). Disturbance of listed marine mammals by ships, including tankers, represents a source of potential impact because of underwater noise levels. Evidence suggests that odontocetes show considerable tolerance of vessel traffic. It is expected that these impacts would be manifested primarily as avoidance behavior by listed marine mammals. Noise from a tanker underway would be temporal and transient. Impacts to cetaceans from noise will be negligible.

Accidents

Large-oil-spill assumptions from the proposed action are presented in Table 4-1e. For the Pacific Region, the assumed source of an accidental oil spill is a tanker transporting oil between the Gulf of Alaska and southern California. Spilled oil may affect marine mammals through various pathways (e.g., direct contact; inhalation of oil or related volatile distillates; ingestion of oil directly, or indirectly through the consumption of oiled prey species; impairment of feeding by fouling of baleen, for mysticetes), as summarized by Geraci (1990). Sections 4.3.2.3. and 4.3.3.3. describe how contact with oil affects cetaceans. While the impacts of direct contact with spilled oil would be unavoidable, individuals exposed would recover completely, and the viability of the population would not be threatened. Overall, these impacts to listed cetaceans are expected to be moderate.

Oil-spill response activities that may affect cetaceans involve the application of dispersant chemicals to spilled surface oil. Dispersants are generally classified as being of low toxicity as compared to the toxic constituents of crude oil. There are currently few data sources that detail the effects of oil dispersants on marine mammals.

Oil-spill response equipment and support vessels will also produce underwater noise. Oil-spill response support vessels may also increase the risk of collisions between vessels and listed marine mammals. However, spill response activities and the possible use of dispersants are expected to be localized and infrequent. Therefore, potential impacts to listed cetaceans from oil-spill response activities are expected to be negligible.

The number of whales affected by an accidental oil spill would depend on the time of year and duration of the spill, the quantity of the spill, the density of the whale population in the vicinity of the spill, and the individual whale's ability to avoid the spill. Because gray whales are present along the west coast on a limited basis (i.e., primarily during their twice-a-year migrations), the potential for spill contact is also limited. If present, gray whale contact with an oil spill would be most harmful during summer migration northward, when mother and calves are present. Contact with oil would most likely have minor effects on gray whales or other nonlisted cetacean species of the Pacific Region. As noted in the previous discussion regarding killer whales in Alaska (Section 4.3.3.3.1), accidental oil spills are most dangerous to killer whales when contaminated prey is ingested (Geraci, 1990; Würsig, 1990). Further, killer whales do not appear to avoid oiled areas, increasing the risk of contamination. There is the possibility that bioaccumulation of toxins could lead to fatalities; however, a single spill of 7,800 bbl associated with the proposed action is not expected to produce such an impact. Impacts to killer whales from an oil spill resulting from the proposed action are expected to be negligible.

Oil-spill response and cleanup operations are expected to produce only minor impacts to gray whales due to their limited seasonal presence along the west coast, the projection for a single spill to occur in deep water (distant from preferred migratory pathways), and assumed spill size. Other nonlisted cetaceans present in the area of a spill would be temporarily disturbed by the presence of response equipment, a minor impact.

***Conclusion**:* Impacts on cetaceans, both listed and nonlisted, due to routine tankering operations (i.e., discharges, tanker traffic, noise) are expected to be **negligible**. Potential impacts of an accidental 7,800-bbl oil spill in deep water of the Pacific Region and oil-spill response activities on listed cetaceans would be **moderate** and **negligible**, respectively. Impacts from oil exposure associated with a 7,800-bbl spill and oil-spill response activities will range from **negligible** (for killer whales) to **minor** (for gray whales and other nonlisted cetaceans).

4.3.4.3.2. Pinnipeds

There are two listed pinniped species found within waters of the Pacific Region: the Guadalupe fur seal and the Steller sea lion. Descriptions of the listed and nonlisted pinnipeds found in the Pacific Region can be found in Section 3.3.2.1.

Routine Operations

Routine tanker vessel traffic and associated discharges are not expected to produce impacts to listed pinniped species, given that tanker traffic would be offshore in deep water and removed from favored, nearshore coastal and/or insular waters. Discharges would be diluted and dispersed rapidly in offshore waters. Routine tanker vessel traffic and associated discharges are not expected to produce impacts to either California sea lions or northern elephant seals, given that discharges would be quickly diluted and dispersed. Although these species may be found in offshore waters, tanker noise should provide adequate warning of an approaching vessel. Seals and sea lions should be clear of the tanker and its discharges. Routine tanker operations are expected to produce negligible impacts to any of the listed and nonlisted pinniped populations.

Accidents

Accidental oil spills may contact and impact pinnipeds through their inhalation of hydrocarbon vapors, a loss of prey organisms, ingestion of spilled oil or oil-contaminated prey, contamination of rookeries or haulouts, and skin and/or sensory-organ damage. While other pinnipeds are insulated with a thick fat layer (Steller sea lion), fur seals rely on their thick fur for insulation. Oiling of a fur seal sufficiently to mat the fur can result in hypothermia and death. Females returning from foraging at sea could also contaminate pups with oil.

Steller sea lions, whose rookeries and haulout areas are more prevalent in northern California and Oregon (Bonnell et al., 1983, 1991; Hill and DeMaster, 1999), would be affected by spilled oil if it were to directly contact individuals, rookeries, haulouts, or major prey species. Guadalupe fur seals are very uncommon in the Pacific Region, with only one or two individuals sighted annually on a seasonal basis on the Channel Islands. Given that a single spill of 7,800 bbl is assumed under the proposed action (Table 4-1e) , if an oil spill were to occur near areas where and when Steller sea lions or Guadalupe fur seals are present, impacts would be minor. A tanker spill that might occur elsewhere along the west coast route is expected to produce negligible impacts to listed pinniped species.

California sea lions range throughout the Pacific Region, from British Columbia to Mexico. This species typically remains at sea, returning to land only to breed and molt. Breeding occurs during the winter (December to March), with molting occurring in April-May or mid-summer. Bonnell and Dailey (1993) note that more than half of the northern elephant seal population is associated with rookeries on the Channel Islands off southern California. Off Washington and Oregon, most elephant seal sightings have been noted over the shelf and slope, usually during summer. Off California, such sightings are predominantly in inshore waters, with only limited sightings beyond the continental slope (Bonnell and Dailey, 1993).

Vessel and human activity associated with cleanup efforts may cause sea lions to abandon coastal haulout areas and/or rookeries for an extended period of time. Steller sea lion presence in the Pacific Region is very limited, with only occasional sightings noted since 1983. Given their limited presence in the region, the potential for spill contact is very low. Further, only a few individuals might be affected. Impacts to the Steller sea lion population from an oil spill and associated spill cleanup operations are expected to be minor.

Oil spills could directly affect seals and sea lions by causing toxic stress. Localized displacement from oil-spill cleanup operations could adversely affect their ability to forage. Oil contact could lead to conjunctivitis and skin irritation, while ingestion could lead to liver and brain lesions, as documented for seals exposed following the 1989 *Exxon Valdez* oil spill off Alaska (Spraker et al., 1994). On the basis of their numbers and presence in the Pacific Region and their use of offshore waters, an accidental oil spill could possibly kill individual seals and sea lions, producing a minor impact to local populations.

Conclusion: Impacts of routine tankering operations from the proposed action on listed and nonlisted pinnipeds would be **negligible**. Potential impacts of a 7,800-bbl tanker spill in deep water of the Pacific Region would be **negligible** unless a spill occurred in those areas where Steller sea lions or Guadalupe fur seals are found, in which case the impact would be **minor**. Impacts of a 7,800-bbl tanker spill on nonlisted pinnipeds would be **minor**.

4.3.4.3.3. Fissipeds

Routine Operations

Discharges are the only impact producing factor that may affect fissipeds of the Pacific Region. Routine tanker vessel traffic and associated discharges are not expected to produce impacts to southern sea otters, as discharges will occur while tankers are in transit well offshore in deep water. Given the sea otter’s preference for nearshore coastal waters, the potential for contact with a transiting vessel and its discharges is extremely low. Routine tanker operations are expected to produce negligible impacts to the southern sea otter population.

Accidents

As with fur seals, southern sea otters (*Enhydra lutris*) rely solely on their fur for insulation (Rotterman and Simon-Jackson, 1988) and regularly groom themselves to maintain proper insulation. For these reasons, the species is highly vulnerable to direct oil contamination. Other long-term effects from an oil spill on sea otter populations include loss or contamination of prey, and physiological changes occurring in otters subjected to contaminated forage and sublethal levels of direct oiling.

The most recent evidence of oil-spill impact on sea otters comes from surveys conducted in Prince William Sound following the 1989 *Exxon Valdez* oil spill. As stated previously, significant decreases in sea otter abundance were not noted in oiled areas, based on aerial survey efforts. However, boat-based surveys indicated a 35-percent decline in sea otter numbers in oiled areas of Prince William Sound. Garrott et al. (1993) estimated an acute mortality of 2,800 sea otters resulting from the spill. Agler and Kendall (1997) concluded that sea otter populations in the spill areas showed continued effects from the *Exxon Valdez* spill, even though limited baseline data have restricted their ability to determine injury and assess recovery. Doroff and Bodkin (1996) determined that prey composition and foraging success of sea otters did not differ among oiled and non-oiled study sites 2 years after the spill. Tissues of subtidal bivalve prey did not differ in amount of present hydrocarbons throughout the study area. However, juveniles were found to feed more frequently in intertidal regions. Ballachey et al. (1999) found that biomarkers in the blood of sea otters from oiled areas of Prince William Sound continue to remain at elevated levels, suggesting that oil exposure has continued. It remains unclear whether this exposure has, or will continue to, negatively influence population recovery.

Although the spill size under the proposed action is relatively small (single spill of 7,800 bbl—Table 4-1e), impacts from accidental oil spill exposure along the central California coast would be unavoidable, should the oil reach nearshore coastal waters and associated sea otter habitat. Following oil exposure, sea otters would be expected to recover completely if no other serious impacts were to occur (i.e., the viability of the population would not be threatened). Therefore, impacts to southern sea otters from oil exposure would be moderate.

Oil-spill response activity in the offshore region is not likely to affect sea otters inhabiting nearshore coastal waters. However, if cleanup operations were required nearshore, some disruption of normal daily activity for sea otters present would be expected. Sea otters would abandon their normal foraging and resting areas during cleanup operations, due to noise and vessel presence. Once spill cleanup activities were terminated, sea otters would return to the area. Impacts to sea otters from spill response and cleanup operations would be minor.

Conclusion**:** Routine tanker operations from the proposed action are expected to produce **negligible** impacts to the southern sea otter population. Potential impacts to the resident southern sea otter population from a 7,800-bbl tanker spill offshore the central California coast would range from **minor** (for spill response and cleanup activity) to **moderate** (for oil exposure).

4.3.4.4. Marine and Coastal Birds

The six listed species of marine and coastal birds noted for the Pacific Region, and described in Section 3.3.2.2, are the California least tern, California brown pelican, light-footed clapper rail, bald eagle, marbled murrelet, and western snowy plover. The nonlisted seabirds and shorebirds are also described in section 3.3.2.2. Seabird abundance estimates for the Pacific Region are highest over the shelf waters off Washington and Oregon, with strong seasonal fluctuations. The majority of shorebirds that frequent the coasts and shorelines of the Pacific Region have migrated from Alaska, with southward migrations occurring between August and October, reflecting species-specific dispersal patterns.

Routine Operations

The only “routine” activity occurring in the Pacific Region under the proposed action will be tanker traffic associated with the transport of Alaska OCS oil. Routine tanker vessel traffic and associated discharges are not expected to produce measurable impacts to either seabirds or shorebirds of the Pacific Region. Nearly 30 different species dominate offshore waters, where total abundance estimates may reach 4-6 million birds in coastal upwelling zones (e.g., off Pt. Conception) during fall and winter. Tanker discharges would be quickly diluted and dispersed in the water column. Under conditions where birds may be diving or resting on the water near tanker routes, exposure to discharged material would be very unlikely. Further, tanker routes do not approach favored coastal nesting habitats for the species noted in section 3.3.2.2. Therefore, routine tanker operations are expected to produce negligible impacts to listed bird species and nonlisted seabird and shorebird species.

Accidents

Impact producing factors associated with a 7,800-bbl oil spill from a tanker in deep water (Table 4-1e) include oil exposure and oil-spill response and cleanup activities. Effects of a 7,800-bbl oil spill along the west coast could be short or long term and restricted in area affected or wide ranging, depending upon the spill location, season, and local current and wind conditions. Wind and currents can spread oil over large areas, where it may wash up onto beaches and/or contaminate food resources in coastal waters. While an oil spill in deep water travelling to coastal habitats appears unlikely, such contamination of coastal areas is possible under certain oceanographic and meteorological conditions (i.e., surface winds and currents heading toward shore).

Oil spills represent a significant threat to seabirds and, depending upon the short-term fate of oil, shorebirds as well. Seabirds are particularly susceptible to oil in the marine environment because they are the most likely to come in contact with offshore spills. The survival rate for oiled birds is low, and it is likely that most birds coming into contact with oil would not survive. Impacts from oil contact will vary depending upon the number of birds affected. Should oil enter coastal areas, species that use beaches or estuarine habitats for feeding, nesting, and brood-rearing would suffer negative impacts via contamination of sediments, vegetation, and invertebrate food sources. Oil that gets into shallow offshore benthic food supplies can also be toxic to birds that feed in these habitats. The impacts of contamination of food supplies for birds would be minor to moderate on bird populations.

Oil contacting feathers directly causes the feathers to loose their insulating capabilities. Birds can then die from hypothermia or drowning. Oil ingested by preening birds may be toxic. Aside from direct contact with the oil spill, eggs of nesting birds may become contaminated by oiled feathers of incubating adults, which, in turn, produces toxic effects on chick embryos (Patten and Patten, 1979; Stickel and Dieter, 1979). A tanker spill anywhere along the tanker route (between Washington and southern California) could impact large numbers of birds using these waters for feeding during both breeding and nonbreeding seasons. Areas of particular concern include southern California’s offshore islands (e.g., Channel Islands), sandy beaches, nearshore coastal waters, and wetland areas.

California least terns may be susceptible to oil contact if oil were to reach the nearshore marine waters (where least terns forage, all California nearshore waters possible) or sandy beaches (breeding sites) of southern California. The endangered California least tern breeding colonies occur along the southern California coast, where they utilize undisturbed sandy beaches or the shoreline of estuaries or lagoons. This species also ranges further north, into northern California.

While the endangered California brown pelican ranges along the entire U.S. west coast, breeding and nesting is restricted to two of the Channel Islands (Anacapa Island and Santa Barbara Island) off California. Most foraging (via diving) occurs in nearshore coastal waters, within 11 km of the coast, although pelican sightings have been made much further offshore. This species is considered susceptible during foraging (throughout the Pacific Region) and nesting (Channel Islands area only).

The endangered light-footed clapper rail is a coastal marsh inhabitant found exclusively in southern California and northern Baja California. This species feeds on a variety of marsh invertebrates (e.g., crabs, crayfish, tadpoles, insects) and is not likely to be affected by spilled oil unless the oil penetrates a coastal marsh.

The bald eagle occurs predominantly in inland areas or in coastal areas of Washington and Oregon (including around Puget Sound and the Strait of Juan de Fuca, or along the Pacific coast). Potential for oil contact is greatest for spills that may reach the nearshore coastal waters of Washington or Oregon.

The threatened marbled murrelet population of the Pacific Region tends to be restricted in its distribution by presence of suitable nesting habitat. While nesting sites (in old growth coniferous forests) may not be threatened by an oil spill, foraging individuals found in nearshore marine waters may be susceptible to oil contact.

The threatened western snowy plover, consisting of both resident and migratory individuals, typically breeds on coastal beaches from southern Washington to Baja California. Preferred nesting habitat consists of flat, open areas of sand along sand spits, dune-backed beaches, unvegetated beach strands, open areas around estuaries, and beaches at river mouths.

Shorebirds (i.e., those species that use shorelines of the open coast and offshore rocks, as well as protected shores of wetlands, estuaries, bays, and lagoons) in the Pacific Region include plovers, sandpipers, and avocets. Species using sandy beaches include plovers (black-bellied, semipalmated), willets, whimbrels, marbled godwits, sanderlings, and sandpipers (least, western). Species using rocky shorelines or offshore rocks include oystercatchers, turnstones (black, ruddy), spotted sandpipers, and surfbirds.

Oil reaching these coastal environments while listed species are present could produce moderate to major impacts depending on the amount of oil, location, and timing of the spill. Impacts of oil reaching coastal environments would be minor for nonlisted bird species on the basis of their numbers and distribution.

Oil-spill response, cleanup, and containment activities may, depending upon the location of the tanker spill and the direction in which the spill is transported (e.g., directly toward avian high-use areas), have adverse effects on avian populations. For example, if a tanker spill were to occur near areas where one or more listed bird species forage (e.g., offshore southern California, near the Channel Islands), individuals would be temporarily displaced during cleanup operations. Use of skimming vessels in nearshore waters, or the presence of personnel and equipment on affected beaches, could disrupt breeding and nesting activity for select species (e.g., brown pelican). Following cleanup operations, the affected avian resources may or may not recover completely, yet the viability of affected bird populations would not be adversely affected; therefore, impacts from response activities would range from minor to moderate.

Conclusion: Routine tanker operations from the proposed action are expected to produce **negligible** impacts to listed and nonlisted seabird and shorebird species. If a large tanker spill were to occur and contact birds or coastal environments, impacts could be **moderate**. The level of impact would depend on the spill size, location and timing of the spill, as well as the bird species that may be present.

4.3.4.5. Fish Resources

Major fish groups of the Pacific Region have been summarized in Section 3.3.2.3, including anadromous fishes, soft-bottom and hard-bottom fishes, coastal pelagic fishes, epipelagic fishes, midwater fishes, demersal fishes, and highly migratory fishes.

Routine Operations

Routine discharges from transiting tankers are unlikely to affect fish species occupying midwater and benthic habitats (e.g., soft and hard bottom fishes, demersal fishes, midwater fishes) because discharges will become diluted quickly in surface waters. Surface dwelling fishes (e.g., coastal pelagic fishes, epipelagic fishes) and those fish species that undergo long migrations (e.g., highly migratory fishes) may be present when discharges occur. However, given the high dilution rate of tanker discharges in the open ocean, such discharges should have no measurable effect on fish resources.

Accidents

Impact producing factors associated with a large oil spill from a tanker in deep water (Table 4-1e) that may affect fish resources include oil exposure and oil-spill response and cleanup activities (i.e., dispersant use).

While oil spills are known to cause large fish kills in enclosed fresh or brackish waters, there have been no reports of large fish kills attributable to oil exposure in open, well-mixed coastal and ocean waters (Teal and Howarth, 1984). Concentrations of petroleum hydrocarbons rarely reach high enough values or remain high for long enough in the water column, even under a surface oil slick, to cause serious harm to populations of adult fishes. Pelagic eggs and larvae, particularly those that float at or just below the sea surface, are vulnerable to oil pollution. These early life stages of fishes are usually much more sensitive than the adults to toxic effects of crude oil (Capuzzo, 1987). Contact with oil on the surface or with dissolved or dispersed hydrocarbons in the upper water column may kill large numbers of embryos and larvae. Longwell (1977) reported increased mortality of floating cod and pollock eggs collected from the path of spreading Bunker C residual oil from the 1976 wreck of the *Argo Merchant* off Nantucket. Small specks of viscous oil adhered to many of the eggs, but not all died or produced deformed larvae. Pearson et al. (1985) reported that small oil droplets adhering to the surface of herring eggs were nearly always lethal to the embryos. However, natural mortality among planktonic eggs and larvae of marine fishes and invertebrates is very high (McGurk, 1986). Oil-induced mortality would occur in conjunction with normal mortality of eggs and larvae. Such decreases in eggs and larvae, however, are not expected to be reflected in a decrease in the population size of adult fishes.

Impacts from oil exposure vary between fish groups. For example, salmon exposed to sublethal concentrations of hydrocarbons may become contaminated. Local salmon fishing operations may also be forced to close, with potentially substantial economic ramifications. Exposure to oil has variable effects on salmon resources, depending upon the species and numbers present, life stage, and spill fate (e.g., amount of time oil is on the surface or sediments, level of spill response, degree of weathering, etc.).

Impacts of spilled oil differ among various life stages of fishes. For those species within the upper portions of the water column (e.g., coastal pelagics, epipelagics, highly migratory species), hydrocarbons from spilled oil can affect adults via direct contact with gills or in the gut following ingestion. Species preferring midwater and benthic environments (e.g., midwater fishes, soft and hard bottom fishes) will be at reduced risk from oil exposure. The toxic fractions of oil (e.g., PAH's) can cause death or illness in adults; however, exposure must be continuous. Adult and juvenile fishes are expected to actively avoid an oil spill. Planktonic eggs and larvae would be unable to avoid spilled oil. Eggs and larvae of fishes will die if exposed to certain toxic fractions of spilled oil. If a large tanker spill (7,800 bbl) were to occur, impacts to fish resources from oil exposure would be unavoidable. Fish resources would be expected to recover completely following the spill. Therefore, impacts to fish populations would be minor.

While spill response and mechanical cleanup activities are not expected to adversely affect any fish resources, the possible use of dispersants has the potential to adversely affect eggs, larvae, juvenile, and adult forms that occur at or near the ocean surface. During the early years of dispersant development and use, dispersant application was acknowledged to have caused more environmental damage than the oil itself (Southward and Southward, 1978). However, considerable advances have been made in dispersant technology in the last 30 years (National Research Council, 1989). Modern oil-spill dispersants have low toxicity to marine organisms and are highly effective in dispersing fresh oil under laboratory conditions. However, there is controversy concerning whether modern dispersants are sufficiently effective for combating a spill at sea to warrant their use as a first response option (Fingas et al., 1991; Lunel, 1995). The current consensus is that dispersants can be effective if applied early while the oil is still dispersible.

If applied, dispersants are expected to produce minor impacts to fish resources. Impacts would be unavoidable; however, affected populations would recover completely once dispersed oil was transported out of the area and further dispersed in open-ocean waters.

Conclusion: Impacts of discharges from routine tanker operations on fish resources would be **negligible**. Potential impacts on fish resources of the Pacific Region from a large tanker spill would be **minor**.

4.3.4.6. Sea Turtles

Routine Operations

Four species of sea turtles, the green, leatherback, loggerhead, and Pacific ridley (all are listed as either endangered or threatened), are known to frequent waters of the Pacific Region. However, their presence in these waters has been categorized as uncommon, and there are no designated critical habitats or migratory routes for sea turtles in the Pacific Region, as detailed in Section 3.3.2.4. Because there are no sales proposed for the Pacific Region, the only "routine" activity occurring there will be tanker traffic associated with the transport of Alaska OCS oil. Impacting factors that may be associated with tankering include discharges, collisions, and noise. Operational discharges include components that may be injurious to sea turtles. However, tanker discharges will be rapidly diluted after discharge, minimizing impacts on sea turtles. Therefore, impacts would be negligible. Adult and juvenile sea turtles are capable of avoiding moving vessels, and the chance of collision between tankers in shipping lanes and sea turtles is low. Should individual turtles be killed from collisions with tankers, the impact on the population would be negligible. The most likely responses of sea turtles to noise from tankers are expected to be diving and evasive swimming (refer to noise discussion in Section 4.3.2.7). Because of the limited presence of sea turtles in shipping lanes and the temporary nature of responses to noise, impacts are expected to be negligible.

Accidents

Impact producing factors associated with a 7,800-bbl oil spill from a tanker (Table 4-1e) that may affect Pacific sea turtles include oil exposure and oil-spill response and cleanup activities.

Spilled oil may affect sea turtles through various pathways: direct contact, inhalation of oil or related volatile distillates, ingestion of oil (directly, or indirectly through the consumption of oiled prey species), and ingestion of floating tar (Geraci, 1990). Direct oil contact to sensitive tissues (e.g., eyes, mucous membranes) produces irritation and inflammation. Oil can adhere to turtle skin or shells; however, no evidence of resultant tissue damage exists. Turtles surfacing within or near an oil spill may inhale petroleum vapors. However, short-term inhalation of petroleum vapors at concentrations similar to those found in oceanic oil spills may not be necessarily detrimental either in terms of structural tissue damage or respiratory gas exchange. Sea turtles have shown apneic response when confronted with disagreeable odors; turtles may be able to minimize their exposure to inhaled petroleum vapors. Ingested oil, particularly lighter fractions, can be toxic to sea turtles. The oil may remain within the gastrointestinal tract and be absorbed into the bloodstream. Once ingested, oil may irritate and/or destroy epithelial cells in the stomach and intestine. Certain oil components are carcinogenic. There is no direct evidence for significant biomagnification of hydrocarbons in food chains. Hydrocarbons, in general, are readily metabolized. Hatchling and juvenile turtles feed opportunistically at or near the surface in oceanic waters, and are especially sensitive to spilled oil and oil residues such as floating tar balls. Locally, impacts to sea turtles that may be present are expected to be moderate; yet, impacts to the resource would be minor. Impact producing factors from any cleanup operations would include dispersants, noise and collisions with cleanup vessels. No impacts are expected from shoreline cleanup operations. Overall, any impacts realized from cleanup operations would be negligible and temporary.

Conclusion: Impacts of routine tankering operations on sea turtles would be **negligible**. If a tanker spill (7,800 bbl) were to occur and contact sea turtles, the overall impacts would be **minor**. Impacts from cleanup operations would be **negligible**.

4.3.4.7. Coastal Habitats

4.3.4.7.1. Wetlands and Estuaries

Wetland and estuarine habitats along the coast of the Pacific Region consist of salt marshes, eel grass beds, fresh and brackish water marshes, and mudflats (see Section 3.3.2.5.1). Wetland habitats may occupy only narrow bands along the shore, or they may cover larger expanses at the mouths of bays, rivers, or coastal streams. Estuaries are important habitat for both resident and transitory species, providing spawning or nursery habitat and foraging area for numerous species, including invertebrates, fishes, reptiles, birds, and mammals.

Along the coasts of Washington and Oregon, estuaries are typically larger than those found further south. Important estuaries in this portion of the Pacific Region include Puget Sound, Columbia River estuary, Coos Bay, and Grays Harbor. In northern and central California, estuaries provide spawning and nursery habitat for marine fishes and invertebrates and roosting and foraging areas for migrant and resident birds. Major estuaries in this portion of the Pacific Region include San Francisco Bay, Bodega Bay, and Humboldt Bay. Major estuaries in southern California have seen significant degradation and loss over the past several decades, primarily as a result of upland and coastal development, channel dredging, and other development activities. Major southern California estuaries include Mugu Lagoon, Anaheim Bay, Goleta Slough, and Carpinteria Marsh.

It is very unlikely that discharges from routine tankering operations will reach wetlands and estuaries. The most likely cause of impacts would be a tanker spill. It is assumed that one 7,800-bbl oil spill from a tanker carrying oil from the proposed action could occur somewhere along the west coast during the life of the proposed action (Table 4-1e). Impact producing factors associated with a 7,800-

bbl oil spill from a tanker in deep water include oil exposure and oil-spill response and cleanup activities. Impacts to wetlands and estuaries from a spill could only be expected under select conditions. While transiting far offshore (> 75 km), it is not expected that a tanker spill in deep water would affect wetlands and estuaries. Oil released offshore will weather, and toxic fractions will dissipate and evaporate. It is very unlikely that an offshore spill will reach sensitive wetland or estuarine habitats.

Tankers entering port have the greatest potential to adversely affect local wetland or estuarine environments (e.g., Puget Sound, San Francisco Bay). Should a spill occur closer to shore, it is possible that these resources could be oiled. Cleanup operations would be damaging, and oil would remain in the environment for years. Wetland fauna (e.g., resident or migratory birds) may also be susceptible to direct oiling if a spill were to reach wetland or estuarine habitat. The magnitude of the oil-spill related impacts would also depend upon the size of the spill and sensitivity of indigenous flora and fauna exposed to oil. Under these conditions where a spill reached wetland or estuarine habitat, impacts would be unavoidable. Following cleanup operations, wetlands or estuaries would be expected to recover over time.

Cleanup operations in estuarine or wetland habitats are problematic, with oiled vegetation and fine sediments difficult to remediate. Use of heavy equipment or manual labor to achieve cleanup in these habitats can be nearly as damaging as oil exposure. The effects of remedial action are unavoidable (if cleanup operations proceed); however, over time these habitats would be expected to recover.

Conclusion*:* Impacts from a tanker spill to the majority of wetlands and estuaries within the Pacific Region would be **negligible;** however, for those resources located near major tanker ports, oil-spill impacts would be **moderate** for both oil exposure and subsequent cleanup activities.

4.3.4.7.2. Intertidal Benthos

The two most prominent beach types found in the Pacific Region are rocky shores or sandy beaches, the latter of which is most common (see Section 3.3.2.5.2). Sandy beaches occur throughout the Pacific Region and represent less stable environments than rocky shores (i.e., seasonal changes in beach profile due to wind and wave exposure and effects of nearshore currents). While less extensive than sandy beaches, rocky intertidal zones are most prominent from southern Oregon to southern California and along the Channel Islands of southern California. Rocky substrate provides suitable surfaces for the attachment of invertebrate and algal species that can alternately withstand the physical stresses of wave action and desiccation.

Routine Operations

It is very unlikely that discharges from routine tankering operations will reach and subsequently affect intertidal benthos. Therefore, impacts would be negligible.

Accidents

The accidental release of 7,800 bbl of oil may have an impact upon intertidal benthos, depending upon spill location, degree of weathering, efficiency of spill response and containment, and oceanographic conditions. Spills occurring far offshore are expected to produce negligible impacts to intertidal benthos. If a spill were to occur closer to shore, as a tanker heads into port, intertidal benthic communities near destination ports would be at greater risk of impact. Oiling of intertidal flora and fauna could result in smothering and acute and chronic toxicity. Under these conditions where a spill reached intertidal benthos, impacts would be unavoidable. Following cleanup operations, intertidal areas would be expected to recover over time. Impacts from oil spills would be moderate.

Whereas heavy equipment can be used to clean spilled oil from sandy beaches, manual labor is more likely to be required for cleanup of oiled rocky intertidal sites. Disturbance from cleanup operations on sandy beaches will be limited. On rocky shores, oil may be more persistent and subsequently more difficult to remove. On either shoreline type, impacts from spill response and cleanup would be unavoidable. Each habitat, however, would be expected to recover (i.e., recovery rates would vary, with rocky shores requiring more time [10 or more years] than sandy beaches). Therefore, impacts would be minor.

Conclusion: Impacts of routine tankering operations on intertidal benthos would be **negligible**. If a 7,800-bbl tanker spill were to occur, impacts on intertidal benthos would range from **negligible** (for intertidal areas far removed from tanker traffic lanes and destination ports) to **moderate** (for intertidal areas close to major destination ports). Spill response and cleanup activities would produce **minor** impacts to these habitats.

4.3.4.8. Areas of Special Concern

4.3.4.8.1. Essential Fish Habitat

Three EFH zones have been established within the Pacific Region for coastal pelagic fishes, groundfishes, and Pacific salmon (see Section 3.3.2.6.1.). The EFH for coastal pelagic fishes and groundfishes extend from the coast out to the edge of the Exclusive Economic Zone (EEZ), 320 km offshore, between the U.S-Canada and U.S.-Mexico borders. The EFH for coastal pelagics includes surface waters (i.e., waters above the thermocline) where sea surface temperatures range between 10 ^{o}C and 26 ^{o}C. The EFH for groundfishes includes both surface waters and benthos, extending from the mean high tide line or upriver extent of saltwater intrusion (in river mouths) seaward to the edge of the EEZ.

Routine Operations

Impact producing factors that may affect EFH include operational tanker discharges. Discharges from tankers will be rapidly diluted and dispersed. Because of this rapid dispersal of routine and sanitary wastes, only those pelagic eggs and larvae in the immediate area of the vessel may come into contact with the discharge. Wastes containing chemical additives such as chlorine may kill those epipelagic fish larvae and plankton located at the immediate surface discharge site, but rapid volatilization as well as dilution would result only in temporary and localized effects.

Vessel noise within EFH may make the area undesirable to managed fish species. The noise will cause some fish to move from the area, reducing the EFH available to them. Most fish will return once the vessel leaves.

Accidents

Impact producing factors from accidents that may affect EFH include oil exposure. The accidental release of 7,800 bbl of oil (Table 4-1e) would have the potential to adversely affect water and sediment quality, both of which are primary EFH components. Of major concern is the extent and duration of surface water degradation due to oiling. For a spill of this size, impacts to surface water quality should be of relatively short duration. The severity of impact would depend upon exposure of spilled oil to currents, wind, and turbulence. Degradation of water quality from hydrocarbon contamination arising from a large spill may occur, but would vary in space and time depending upon area-specific decomposition and weathering processes. While a 7,800-bbl spill could introduce minor concentrations of oil (e.g., water soluble fractions) into the water column, this would not measurably degrade water quality, except in the immediate vicinity of the spill source. The probability that oil will affect deep- or shallow-water sediments is low, because it is unlikely that oil will reach the seafloor. An exception rests with the possible introduction of tar balls that sink to the seafloor. Tar ball formation is not expected to be extensive from a 7,800-bbl spill. Therefore, water quality impacts from a tanker spill would be unavoidable, yet the EFH would recover completely following the spill. Sediment quality impacts, if they were to occur, would also be unavoidable, with sediments recovering completely following the spill.

Fish eggs and larvae in surface waters would be at risk from oil exposure. Epipelagic fish larvae, eggs and planktonic prey species contacting oil would be injured or killed. Localized mortality would not result in observable decreases in the population size of adult fishes. Degradation of surface waters would be short term, with natural processes and cleanup operations either removing or dispersing spilled oil. Surface water EFH would rapidly return to its pre-oiled condition.

Coastal habitats, including kelp beds, also support fish populations and are included in a consideration of EFH impacts. During a spill event and under conditions where spilled oil moves into the nearshore coastal environment, kelp canopies might be oiled. (See Section 4.3.4.11.). Following oiling, kelp resources would recover completely.

Conclusion: Impacts on water and sediment quality from routine tankering discharges from this proposed action would be **negligible** due to rapid dispersal of discharged contaminants. Impact from vessel noise would last only as long as it took the ship to move through an area; therefore, noise impacts would be **negligible**. A 7,800-bbl tanker spill in deep water of the Pacific Region would affect water quality in a localized area, and the impact would be unavoidable. Sediment quality degradation is not likely, with the possible exception of tar ball formation. However, because water and sediment quality would recover without mitigation, impacts on EFH would be **minor**.

4.3.4.8.2. Marine Sanctuaries

There are five prominent national marine sanctuaries in the Pacific Region, extending from the northwestern tip of Washington State to southern California (see Section 3.3.2.6.2):

- Olympic Coast National Marine Sanctuary
- Cordell Bank National Marine Sanctuary
- Gulf of the Farallones National Marine Sanctuary
- Monterey Bay National Marine Sanctuary
- Channel Islands National Marine Sanctuary

Routine Operations

It is very unlikely that discharges from routine tankering operations will reach marine sanctuaries of the Pacific Region. Due to high dilution rates, discharges from a moving tanker in offshore waters will be quickly dispersed. Therefore, impacts to marine sanctuaries would be negligible.

Accidents

Impact producing factors from accidents that may affect marine sanctuaries include oil exposure. The accidental release of 7,800 bbl of oil (Table 4-1e) will adversely affect surface waters, one of the primary attributes of each of the five national marine sanctuaries. Marine mammals and birds present within the sanctuary may be oiled, and impacts could be similar to those noted previously for each resource. Oil-spill impacts should be of relatively short duration, the resource would recover completely, and the viability of the marine sanctuary affected will not be threatened. Therefore, a spill reaching a national marine sanctuary is expected to produce moderate impacts.

Conclusion: Impacts of routine tankering operations on marine sanctuaries would be **negligible**. If a tanker spill of 7,800 bbl were to occur and contact a marine sanctuary, impacts could be **moderate**.

4.3.4.8.3. Parks, Reserves, and Refuges

The Pacific Region contains three national parks that border the marine environment (see Section 3.3.2.6.2): Olympic National Park (Washington), Redwood National Park (northern California), and Channel Islands National Park (southern California). National estuarine research reserves have been founded in Washington (Padilla Bay National Estuarine Research Reserve), Oregon (South Slough National Estuarine Research Reserve, Coos Bay estuary), and California (Elkhorn Slough National Estuarine Research Reserve, near Monterey; Tijuana River National Estuarine Research Reserve, near San Diego). California has established select coastal sites of biological importance (termed California Marine Protected Areas), in recognition that such sites represent areas of special concern, including ecological reserves, marine life refuges, and reserves and preserves.

It is very unlikely that discharges from routine tankering operations will reach any areas of special concern in the coastal areas of California. Due to high dilution rates, discharges from a moving tanker in offshore waters will be quickly dispersed. The primary impact producing factor resulting from accidents that may potentially affect parks, refuges, and reserves is oil exposure. The accidental release of 7,800 bbl of oil (Table 4-1e) may have an impact upon the intertidal communities of these coastal areas, depending upon spill location, degree of weathering, efficiency of spill response and containment, and oceanographic conditions. Spills occurring far offshore are expected to produce negligible impacts to parks, reserves, or refuges. If a spill were to occur closer to shore as a tanker headed into port, parks, reserves or refuges located near destination ports would be at greater risk of impact. For example, Olympic National Park beaches could be fouled by a tanker spill in the Strait of Juan de Fuca. Oiling of intertidal flora and fauna could result in smothering and acute and chronic toxicity. Given the unavoidable nature of such a spill and the expected full recovery of affected park resources, such impacts would be moderate.

Conclusion*:* Impacts of routine tankering operations on national parks, estuarine research reserves, and California areas of special concern would be **negligible**. A tanker spill of 7,800 bbl could produce **moderate** impacts to national parks, estuarine research reserves, and California areas of special concern.

4.3.4.9. Fisheries

4.3.4.9.1. Commercial Fisheries

Major commercial fisheries in Washington and Oregon operate from ports within Puget Sound, Grays Harbor, Willapa Bay, Astoria, Newport, and Coos Bay. Target species are area-specific and are detailed in Section 3.3.3.1.

Routine Operations

Discharges from routine tankering include sanitary and domestic wastes, deck drainage, and miscellaneous wastes. These wastes are released into the ocean in accordance with NPDES permits issued by the USEPA and rapidly dilute in the water column. Surface dwelling fishes of commercial importance (e.g., coastal pelagic fishes, epipelagic fishes) and those fish species that undergo long migrations (e.g., highly migratory fishes) may be present when discharges occur. Routine discharges from transiting tankers are unlikely to reach commercial fish species occupying midwater and benthic habitats (e.g., soft- and hard-bottom fishes, demersal fishes, midwater fishes) because discharges will become diluted quickly in surface waters. Discharges are unlikely to reach the shallow, nearshore environment where kelp is harvested.

Space-use conflict issues may arise which will require frequent radio communications between tanker captains and commercial fishing vessel captains. Exchange of information including coordinates, destination, vessel speed and type of fishing gear will minimize conflicts.

Vessel-associated noise may cause epipelagic fish to relocate away from the immediate location of the vessel.

Accidents

Impact producing factors from accidents that may affect commercial fishery resources include oil exposure and oil-spill response and cleanup activities. The accidental release of 7,800 bbl of oil (Table 4-1e) would have a short-term effect on commercial fisheries. Commercial fisheries can be affected by accidental oil spills in several ways. Impacts to individuals of target species occur directly by ingestion of spilled oil (Section 4.3.4.5.) and indirectly by degrading habitats that are critical for the survival of target species. These impacts would only be serious to commercial fisheries if they led to large declines in target species populations. A single 7,800-bbl oil spill is unlikely to produce such declines. Other impacts involve interference with fishing operations, preclusion of traditional fishing areas, tainting of catches, public perception of tainted seafood, and fouling of gear (e.g., Bolger et al., 1996; Hom et al., 1996). The ultimate effect to individual fishers is loss of income and, at worst, loss of livelihood in a particular area. Given the size of the spill and its projected occurrence in deep water, large areas of commercial fishing importance are not likely to be affected.

Spill response is expected from one or more of the oil spill cooperatives operating along the west coast. These cooperatives use their own labor, vessel, and equipment inventories, and also draw upon the local labor market and vessels of opportunity, as needed, for short-term assistance.

Adverse effects on kelp from oil exposure will be minimal, based on studies of prior spills and their effects. For example, following the *Tampico* spill in 1957 (as reported by North et al. [1964]) and the 1969 Santa Barbara Channel oil spill (as reported by Ebeling et al. [1971], Foster et al. [1971], and Foster and Holmes [1977]), spill impacts were detected for kelp-associated fauna, yet kelp plants were only slightly affected, as reported by Foster and Schiel (1985). Foster et al. (1971) reported that large quantities of oil from the Santa Barbara Channel oil spill were trapped in the kelp canopy, causing it to turn black. However, the mucous coating on the algae appeared to prevent oil from permanently adhering to healthy fronds. Recovery for other kelp-associated invertebrates (e.g., mysids, amphipods, etc.) would be expected within a year due to rapid reproductive rates (North, 1971). During a spill event and under conditions where spilled oil moves into the nearshore coastal environment, kelp canopies within harvestable beds might be oiled, effectively precluding harvesting operations until the oil is removed via natural or manmade activity. Such preclusion would be of relatively short duration, estimated at several weeks to a month. Kelp resources would recover completely.

Given the size of the assumed spill and the potential for areal preclusion and fishery and kelp resource contamination, impacts from a 7,800-bbl spill are considered unavoidable. However, affected fishery and kelp resources should completely recover, and commercial fishing or harvesting activity should return to normal.

Conclusion*:* Impacts of discharges from routine tankering operations of the proposed action on commercial fishery resources would be **negligible**. If a 7,800-bbl spill were to occur from a tanker, the potential for areal preclusion and fishery resource contamination could result in **minor** impacts.

4.3.4.9.2. Recreational Fisheries

Washington, Oregon, and northern California are generally comparable in terms of the level of public participation in recreational fishing activities. Depending upon the area of interest within the Pacific Region, recreational fishermen may target several different pelagic (e.g., albacore and bluefin tuna), reef-associated (e.g., rockfishes), and demersal fishes (e.g., flatfishes including halibut and several flounder and sole species).

Routine Operations

The effects of routine discharges from the proposed tankering on recreational fishing would be similar to those seen in commercial fishing (Section 4.3.4.9.1). Many fish species targeted by recreational anglers are more coastal in habitat. These fish would be less likely to come into contact with discharges because of their rapid dilution in open-ocean waters.

Space use conflict issues may arise which will require radio communications between tanker captains and recreational boat captains. Exchange of information including coordinates and vessel speed will minimize potential conflicts.

Accidents

Impact producing factors from accidents that may affect the recreational fishery resources include oil exposure and oil-spill response and cleanup activities. The accidental release of 7,800 bbl of oil (Table 4-1e) would have a short-term effect on recreational fisheries. Recreational fisheries can be affected by accidental oil spills in several ways. Impacts to individuals of target species would be the same as stated previously in Section 4.3.4.9.1. Other impacts involve interference with fishing opportunities, preclusion of traditional fishing areas, tainting of catches, public perception of tainted seafood, and fouling of gear (e.g., Bolger et al., 1996; Hom et al., 1996). Bait and tackle sales, boat rental, restaurants, and room rental properties may experience a reduction in income due to a loss of tourists that chose a vacation site based on recreational fishing opportunities.

Conclusion: Impacts of discharges from routine tankering operations on recreational fisheries would be **negligible**. Impacts to recreational fishing-related activities due to an oil spill could be **minor**.

4.3.4.10. Tourism and Recreation

Tourism and recreation are two primary components of the Pacific Region's socioeconomic and sociocultural environment. Recreational activities conducted in the coastal zone are extremely diverse (e.g., sightseeing, camping, clam digging, hiking, biking, beachcombing, picnicking, boating, swimming, diving, wading, sunbathing, surfing, and sportfishing). Many of the national parks, reserves, sanctuaries, State parks, and marine protected areas noted previously in Section 3.3.2.6.2 are preferred destinations for residents and visitors. Tourism activities represent an important revenue source to local and State economies. The perception of a pristine environment is a major factor attracting tourists and coastal residents to the shore. In California, tourism and its indirect effects at the local and State level account for several billion dollars in income annually.

Routine Operations

It is very unlikely that routine tankering operations would adversely affect tourism and recreation activities in the Pacific Region. Ports receiving tanker traffic as a result of the proposed action are heavily used by commercial shipping interests. Thus, the public is accustomed to shipping traffic. While in transit, tankers would be operating far offshore, at distances where their operations would remain relatively unnoticed.

Accidents

Impact producing factors from accidents that may affect tourism and recreation include oil exposure and oil-spill response and cleanup activities. The accidental release of 7,800 bbl of oil from a tanker operating in deep water (Table 4-1e) could have a short- to long-term effect on recreation and tourism. Under conditions where the spill remains offshore, recreational resources and associated activity would not be affected. Oil transported to shore may reach nearshore coastal waters. Tourism and recreation resources may be closed to the public while cleanup operations are completed. While spill response and cleanup may restore tourism and recreation resources after a spill, public perception regarding fouled beaches and wildlife may remain for some time following a spill. Under these circumstances, impacts to recreation and tourism resources and associated activity (on a local level) would be unavoidable. Recreation and tourism activity would return to normal following cleanup operations; however, the public perception may require considerably more time.

Conclusion: Impacts of routine tankering operations on Pacific Region tourism and recreation would be **negligible**. Given the potential for beach closures and the alteration of public perception regarding tourist destinations and the pristine nature of the coast, impacts from a tanker spill could be as high as **moderate**.

4.3.4.11. Sociocultural Systems and Environmental Justice

Sociocultural systems present in the Pacific Region are represented by various cultural groups, as outlined in Section 3.3.3.3. Of particular concern are Native Americans who routinely use the coastal areas and marine resources of this region, including the Makah Tribe of the Pacific Northwest (i.e., Olympic Peninsula, Neah Bay, and Cape Flaherty region). Recently, the International Whaling Commission and NOAA approved the annual take of a limited number of gray whales for an aboriginal subsistence harvest by the Makah. The NOAA is currently evaluating the environmental impact of this removal on the eastern Pacific gray whale population.

As outlined previously in Sections 4.3.2.15 and 4.3.3.15, the concern over environmental justice issues must be considered, per requirements of Executive Order 12898 issued in 1994. It specifies that ". . . each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations" (59 FR 7629). This section will consider both sociocultural systems and environmental justice in the Pacific Region.

Routine Operations

Routine tankering operations and their associated discharges would not affect sociocultural systems of the Pacific Region, including the subsistence whaling efforts of the Makah. No measurable effects of tankering or tanker discharges would be evident. Therefore, routine operations would produce negligible impacts to sociocultural systems.

For the Gulf of Mexico and Alaska Regions, routine operation impact discussions presented previously (Sections 4.3.2.15 and 4.3.3.15, respectively), concerning the issue of environmental justice, related primarily to the potential location of new onshore infrastructure. Routine tankering operations under the proposed action would use existing port and oil offloading facilities on the U.S west coast. Therefore, there would be no disproportionately adverse effects on low-income or minority communities of the Pacific Region from the proposed actions tankering activities.

Accidents

Under the proposed action, it is assumed that a 7,800-bbl oil spill would occur somewhere along the tanker route between Alaska and southern California (Table 4-1e). In the event that the spill were to occur during the gray whale migration period, and assuming that the spill were to occur offshore of the Olympic Peninsula, the Makah whale hunt could be affected. While oil exposure to marine mammals (including the gray whale) was previously described with direct impacts noted as negligible to minor (Section 4.3.4.3), impacts would be potentially more severe if tribal hunts were delayed or postponed due to oil presence or spill cleanup operations. Under these circumstances, whaling activity would be affected (i.e., delayed or postponed), and the Makah community would have to adjust somewhat to these disruptions. Once spill response and cleanup activity had been completed, the Makah community would return to a pre-spill condition, with no measurable effects from the spill evident. Oil-spill impacts to sociocultural systems would range from negligible to moderate.

As noted above, it is possible that disruption of the Makah gray whale hunt could occur as a result of a tanker spill off the Olympic Peninsula and subsequent transport of oil into waters used by the tribe. Such disruption might produce a short-term, disproportionate impact to the subsistence activities of the Makah Tribe. Following the spill and associated cleanup activities, subsistence activity would resume. A long-term, high adverse disproportionate impact to the Makah is not expected from a single tanker spill.

***Conclusion**:* Impacts of routine tankering operations on sociocultural systems would be **negligible**. An accidental spill that were to occur anywhere within the Pacific Region, except near the Olympic Peninsula during gray whale migrations, would result in **negligible** impacts. However, if a tanker spill were to occur off the Olympic Peninsula during a gray whale migration period, oil-spill impacts to sociocultural systems could be **moderate**. There would be no disproportionately high adverse environmental justice effects on low-income or minority populations of the Pacific Region from the proposed action.

4.3.4.12. Archaeological Resources

The archaeological resources subject to impact in the Pacific Region from offshore oil and gas development include historic shipwrecks or aircraft and inundated prehistoric sites offshore and historic and prehistoric sites onshore. The MMS archaeological baseline studies have identified 4,766 known shipwrecks in the Pacific Region. Most of these shipwrecks occur within 3 miles of the coast, which is within State waters, close to points, harbors, and other hazardous areas. However, shipwrecks do occur in Federal waters, particularly opposite areas such as Point Conception, Point Arguello, or the Port San Luis or Morro Bay harbors. Inundated prehistoric archaeological sites may also exist offshore in the Pacific Region in areas such as submerged embayments, lagoonal deposits, and river valleys where the sites have been buried by sediments and protected from marine erosion.

Onshore historic properties include sites, structures, and objects such as historic buildings, forts, lighthouses, homesteads, cemeteries, and missions. Onshore prehistoric archaeological resources include sites, structures, and objects such as shell middens, campsites, kill sites, and tool manufacturing areas. The MMS archaeological baseline studies have identified 4,443 known prehistoric archaeological sites along the coastline of the Pacific Region. Currently unidentified onshore archaeological sites would have to be assessed after discovery to determine their uniqueness or significance. Sites already listed in the National Register of Historic Places and those considered eligible for the Register have already been evaluated as having the potential for making a unique or significant contribution to science.

Routine Operations

There are no sales planned for the Pacific Region in the 2002 5-year program. Therefore, there will be no impacts to offshore archaeological sites from routine OCS activities.

Accidents

Under the proposal, there will be oil tankered from the Alaska OCS Region to ports in the Pacific Region, and there is potential for oil-spill-related impacts to nearshore and onshore historic and prehistoric archaeological sites should a tanker spill occur. Archaeological resource protection during an oil spill requires specific knowledge of the resource's location, condition, nature, and extent prior to impact. Although existing data compiled for MMS's archaeological baseline studies indicate that there have been 4,443 prehistoric archaeological sites identified along the coastline of the Pacific Region, there may be many more presently unidentified coastal historic and prehistoric sites. Thus, any spill that would contact the land would involve a potential impact to an archaeological site.

If an oil spill were to contact a coastal historic site, such as a fort or a lighthouse, the major impact would be visual due to oil contamination of the site and its environment. This impact would most likely be temporary, lasting up to several weeks depending on the time required for cleanup. Gross crude oil contamination of shorelines is a potential direct impact that may affect archaeological site recognition. Heavy oiling conditions (Whitney, 1994) could conceal intertidal sites that may not be recognized until they are inadvertently damaged during cleanup. Crude oil could also contaminate organic material used in ^{14}C dating, and, although there are methods for cleaning contaminated ^{14}C samples, greater expense is incurred (Dekin et al., 1993). An Alaskan study examining the effects of the 1989 *Exxon Valdez* oil spill on archaeological deposits revealed that oil in the intertidal zone had not penetrated the subsoil, apparently due to hydrostatic pressure (Dekin et al., 1993); however, due to the different environments, these results should not be translated into the Pacific coastal environment without further study.

The major source of potential impact from oil spills is the harm that could result from unmonitored shoreline cleanup activities. Unmonitored booming, cleanup activities involving vehicle and foot traffic, mechanized cleanup involving heavy equipment, and high pressure washing on or near archaeological sites pose risks to the resource. Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with effective training and supervision. As Bittner (1996) described in her summary of the *Exxon Valdez* oil spill: "Damage assessment revealed no contamination of the sites by oil, but considerable damage resulted from vandalism associated with cleanup activities, and lesser amounts were caused by the cleanup process itself."

The National Response Team's, *Programmatic Agreement on Protection of Historic Properties During Emergency Response Under the National Oil and Hazardous Substances Pollution Contingency Plan,* clarifies interagency and regulatory aspects of archaeological site protection during oil spill response. This 1997 agreement outlines the Federal On-Scene Coordinator's responsibility for ensuring that historic properties are appropriately considered in planning and during emergency response.

Conclusion: Under the proposed action, there are no planned sales for the Pacific Region; therefore, there will be no impacts on archaeological resources in the Pacific Region from routine OCS activities. Based on the scenario for the proposal, some impact may occur to coastal historic and prehistoric archaeological resources from accidental oil spills (Table 4-1e). Although it is not possible to predict the precise numbers or types of sites that would be affected, contact with archaeological sites would probably be unavoidable, and the resulting loss of information would be irretrievable. The magnitude of the impact would depend on the significance and uniqueness of the information lost, but based on experience gained from the *Exxon Valdez* oil spill, the impact would most likely be **minor** to **moderate**.

4.4. Environmental Impacts of Alternative 2—Slow the Pace of Leasing

4.4.1. Scenario

Alternative 2 would hold 16 or 17 sales in eight planning areas (Tables 4-2a and b). The pace of leasing would be slower in the Eastern Gulf of Mexico, Beaufort Sea, Chukchi Sea, Hope Basin, and Cook Inlet Planning Areas because fewer sales would be offered than for alternative 1 (the proposed action). There would be one sale rather than two in the Eastern Gulf of Mexico, one or two sales rather than three in the Beaufort Sea, and one sale rather than two in the Chukchi Sea, Hope Basin and Cook Inlet.

Anticipated production values for alternative 2 are presented in Tables 4-2a and b. The amount of hydrocarbons anticipated to be produced would be less than for alternative 1 for the Eastern Gulf of Mexico, Beaufort Sea, Chukchi Sea, Hope Basin, and Cook Inlet because there would be fewer sales in those planning areas. The levels of offshore and onshore oil and gas activities are based on the amount of hydrocarbons expected to be leased, developed, and produced as a result of the sales. Therefore, there will be somewhat less activity in these five planning areas for this alternative (Tables 4-2a and b) than for the proposed action (Tables 4-1a and b).

The same means of transporting hydrocarbons to shore from production facilities in the Eastern Gulf of Mexico, Beaufort Sea, Chukchi Sea, Hope Basin, and Cook Inlet would be used for alternatives 1 and 2. Some of the oil and gas that would not be produced if alternative 2 were adopted would be replaced by foreign oil imported by tankers. The imported oil would be shipped to ports in the Gulf of Mexico and on the west coast.

Table 4-2c presents the number of oil spills assumed to occur and the probability of spill occurrence as a result of Outer Continental Shelf (OCS) activity associated with alternative 2. It is assumed that these spills would occur with uniform frequency over the life of the OCS activities resulting from this alternative. It is also assumed that the number of spills from import tankers would increase somewhat in the Gulf of Mexico and on the west coast because the amount of imported oil increases to replace some of the forgone hydrocarbons if this alternative were adopted.

4.4.2. Gulf of Mexico Region

Slowing the pace of leasing will reduce the number of sales in the Eastern Gulf of Mexico from two to one. There would be no change in the Central and Western Gulf of Mexico Planning Areas where sales would be held annually. It is estimated that the slower pace of leasing would result in the production of approximately half of the oil and gas resources estimated to be produced in the eastern Gulf if two sales were conducted (alternative 1). There would be a corresponding reduction in the level of exploration, development, and production activity. There would be no change in the anticipated oil and gas activity in the central and western Gulf of Mexico.

The reduction in OCS activities will similarly reduce the level of various types of disturbance, effluents and emissions, sedimentation, noise, and other impact agents described in alternative 1. Tables 4-2a and c list the range of activities and oil-spill assumptions, respectively, for alternative 2. The activities potentially causing impacts are the same for both alternatives, and for many resources impact levels cannot be differentiated, either at the local or region level, based on the differences in levels of activity estimated at this programmatic stage. If the same number of sales were conducted in the central and western Gulf of Mexico but one less sale is held in the eastern Gulf, the overall impacts on the following resources would be the same as those estimated for the proposed action:

- air quality
- marine mammals
- marine and coastal birds
- coastal habitats
- national parks, refuges, and national seashores
- national marine sanctuaries
- land use and infrastructure
- tourism and recreation
- sociocultural systems and environmental justice

Because there will be one less sale in the Eastern Gulf of Mexico Planning Area, there will be fewer drilling discharges and, therefore, less turbidity locally. Also, less bottom will be disturbed because fewer platforms, pipelines, and exploration and development ant production wells will be put in place in the Eastern Gulf (Table 4-2a). One of the results will be less sedimentation and smothering of benthic organisms, and prey of adult Gulf sturgeon in particular because their habitat is more closely associated with the eastern Gulf of Mexico. Other fish that feed on benthic organisms may also benefit. Impacts on population, employment, and regional income will be slightly less. Most of these impacts will occur in Alabama, where the supply base will be located, and in Mississippi and Louisiana, where much of the material will be manufactured or fabricated. However, the difference in impacts compared to the proposal will be so slight that for all practical purposes the local economies will not notice it. There will also be less space-use conflicts between the oil and gas industry and commercial fisheries. The decrease in noise and turbidity levels could cause less displacement of fish from their normal habitat. This would most likely affect soft-bottom fish species such as red drum, and sand and spotted sea trout, often targeted by recreational anglers. Because there are likely to be fewer small oil spills in the eastern Gulf, impacts to archaeological resources would be minor locally, but remain minor to moderate overall, as under the proposal.

Although alternative 2 reduces the amount of oil and gas activity in the eastern Gulf, the level of activity will be the same as the proposal in the Central and Western Gulf of Mexico Planning Areas. Because of this activity, the impacts throughout most of the Gulf of Mexico under alternative 2 are expected to be virtually the same as the impacts from the proposal. In summary, while there is expected to be some difference in impacts at the local level in the eastern Gulf for the following resources, the overall impact for these and all other resources is expected to be the same as the proposal.

- water quality
- terrestrial mammals
- fish resources
- seafloor habitats
- essential fish habitat
- population, employment, and regional income
- commercial and recreational fisheries
- archaeological resources

4.4.3. Alaska Region

Slowing the pace of leasing will reduce the number of sales from three to one or two in the Beaufort Sea, and from two to one in the Chukchi Sea, Hope Basin, and Cook Inlet. There would be no change in the number of sales in the Norton Basin. It is estimated that the slower pace of leasing would result in the production of approximately 33-66 percent of the oil resources estimated to be produced in the Beaufort Sea if three sales were conducted and approximately half the hydrocarbon resources estimated to be produced in the Chukchi Sea, Hope Basin, and Cook Inlet (alternative 1). There would be a corresponding reduction in the level of exploration, development, and production activity. There would be no change in the anticipated oil and gas activity in Norton Basin.

The reduction in OCS activities will similarly reduce the level of various types of disturbance, effluents and emissions, sedimentation, noise, and other impact agents described in alternative 1. Tables 4-2b and c list the range of activities and oil-spill assumptions, respectively, for alternative 2. The activities potentially causing impacts are the same for both alternatives, and for many resources impact levels cannot be differentiated, either at the local or region level, based on the differences in levels of activity estimated at this programmatic stage. Overall, if there are fewer sales in the Beaufort Sea, Chukchi Sea, Hope Basin, and Cook Inlet, it is expected that the impacts on the following resources would be the same as those estimated for the proposed action:

- air quality
- marine mammals
- marine and coastal birds
- sociocultural systems
- environmental justice

There would likely be somewhat less impact on water quality in the Beaufort Sea, Chukchi Sea, Hope Basin, and Cook Inlet if alternative 2 were adopted rather than the proposal, but impacts on water quality would be the same for other Alaska planning areas. Because less ocean bottom would be disturbed in these planning areas by this alternative compared to the proposal, sediment release and turbidity would be less. There would also be less drilling discharges (if they were not reinjected), so that impacts in the water column relating to those discharges, such as trace metals, lowered oxygen content, and entrained oil would be less. Because routine activities would still occur as a result of the remaining lease sales in the planning areas, impacts to water quality would be negligible to minor, the same as the proposal. Fewer large spills would be likely to occur in the Beaufort Sea, Chukchi Sea, and Cook Inlet if alternative 2 were adopted rather than the proposal. However, the overall impact to water quality would be minor to moderate as for the proposal, assuming recovery in water quality occurs between the multiple spills under the proposal.

Because there would be fewer helicopter trips to facilities in the Beaufort Sea, Chukchi Sea, and Hope Basin, there will be less noise disturbance to terrestrial mammals, including caribou, muskox, arctic fox, and grizzly bear. There would also be less oil spill contact to the shoreline and coastal habitats. Spills reaching the coast contaminate terrestrial mammals directly by contact or indirectly through their food. The difference between alternative 2 and the proposal in terms of oil-spill effects on terrestrial mammals would only be evident if multiple spills, assumed to occur under the proposed action, were to occur back-to-back without intervening recovery of the terrestrial mammals.

Impacts to essential fish habitat (EFH) are, in part, a consequence of impacts to water quality and benthos. Therefore, it is expected that EFH impacts, including impacts to benthic prey of managed species and associated habitat, would be somewhat less if there were fewer sales. It is also less likely that spilled oil will contact habitat areas of particular concern (HAPC) such as the Stefansson Sound Boulder Patch.

Potential impacts to national parks, refuges, and forests would be the same as for the proposal except for the Arctic National Wildlife Refuge (ANWR). Because less oil would be produced if there are fewer sales in the Beaufort Sea, there will be less chance of multiple oil spills occurring and contacting the shoreline along the northern border of ANWR. This would improve the chances of recovery for coastal fauna contacted by oil and would result in fewer impacts on subsistence use than if three sales are conducted in the Beaufort Sea during the 5-year period of the proposed program.

Employment and regional income impacts will be somewhat less if fewer sales were conducted, although the sales remaining in the leasing schedule would ensure sufficient activity to sustain an effect on population, employment, and regional income at the same level as the proposed action.

In summary, if fewer sales were conducted in the Beaufort Sea, Chukchi Sea, Hope Basin, and Cook Inlet, there would be somewhat less impacts locally for the following resources, but overall the impact level is expected to be the same as for the proposal:

- water quality
- terrestrial mammals
- coastal habitats
- seafloor habitats
- essential fish habitat
- national parks, refuges, and forests
- population, employment, and regional income
- land use and infrastructure
- tourism and recreation
- archaeological resources

4.4.4. Pacific Region

Slowing the pace of leasing in the Alaska Region would reduce the associated oil-spill risk slightly. However, the number of spills that could occur from tankers carrying OCS-produced oil from Valdez to west coast ports under alternative 2 is likely to be the same as the proposal. Therefore, adoption of this alternative could result in impacts to environmental resources in the Pacific Region similar to impacts from the proposal. The nature and severity of these impacts would be the same as those described for the proposed action. Because less oil would be produced in the Alaska Region and transported to west coast ports if this alternative was adopted, the likelihood of these impacts occurring would be slightly reduced.

4.5. Environmental Impacts of Alternative 3—Exclude Some Planning Areas

4.5.1. Scenario

Alternative 3 would hold 17 sales in five planning areas (Tables 4-3a and b). No sales would be held in the Eastern Gulf of Mexico, Norton Basin, or Hope Basin Planning Areas

Anticipated production values for alternative 3 are presented in Tables 4-3a and b. The levels of offshore and onshore oil and gas activities are based on the amount of hydrocarbons expected to be leased, developed, and produced as a result of the sales. No oil or gas would be produced from the proposed program in the Eastern Gulf of Mexico, Norton Basin, and Hope Basin; therefore, there would be no offshore or onshore oil and gas activities resulting from the proposed program in these three planning areas. The estimated oil and gas resources and associated activities would be the same for this alternative as for the proposal in the Central and Western Gulf of Mexico, the Beaufort Sea, Chukchi Sea, and Cook Inlet Planning Areas.

The same means of transporting hydrocarbons to shore from production facilities would be used in all planning areas for alternatives 1 and 3. No oil is expected to be produced in either Norton Basin or Hope Basin during the life of the proposed program, and natural gas from those planning areas is assumed to be used for local consumption on the west coast of Alaska. Therefore, eliminating sales in those two planning areas would have little or no effect on foreign imports. Some of the oil and gas that would not be produced in the Eastern Gulf of Mexico Planning Area if alternative 3 were adopted would be replaced by foreign oil imported by tankers. The imported oil would be shipped to ports in the Gulf of Mexico.

Table 4-3c presents the number of oil spills assumed to occur and the probability of spill occurrence as a result of OCS activity associated with alternative 3. It is assumed that these spills would occur with uniform frequency over the life of the OCS activities resulting from this alternative.

4.5.2. Gulf of Mexico Region

Although there will be no sales in the Eastern Gulf of Mexico Planning Area if alternative 3 were adopted, there would be no change in the Central and Western Gulf of Mexico Planning Areas where sales would be held annually. The anticipated oil and gas activity in those two planning areas would be the same as for the proposal. Some impacts could still occur in the Eastern Gulf of Mexico from oil and gas activities in the Central Gulf. Impacts to coastal resources in Florida are much less likely, however, because of its distance from any offshore activities from the proposed program.

Because water discharges and potential oil spills would be eliminated in the Eastern Gulf, impacts to water quality offshore Florida would be negligible, although impacts to water quality overall would be minor to moderate, the same as the proposed action, because of activities in the Central and Western Gulf of Mexico. Air quality impacts to portions of Alabama and Florida would be reduced; however, minor impacts are still predicted in those areas due to air emissions from oil and gas activities in the adjacent Central Gulf of Mexico Planning Area.

The distribution of the West Indian Manatee in the Gulf of Mexico is coastal, primarily along the Florida peninsula. The primary threat to the manatee would be from oil spills in the Eastern Gulf of Mexico, and alternative 3 eliminates the potential spills occurring in that planning area. Therefore, the potential impact to the West Indian Manatee would be negligible. Impacts to nonlisted marine mammals would also be reduced somewhat locally. Because the level of activity, if alternative 3 were adopted, would be the same as the proposal in the Central and Western Gulf of Mexico Planning Areas, the potential impact to the sperm whale would be minor, and impacts to all other marine mammals would be minor to moderate, the same as the proposed action.

If the proposal were adopted, oil and gas activities in the Eastern Gulf of Mexico would be limited to deep water and no oil pipelines are expected in Florida coastal waters. Therefore, potential impacts to the Florida salt marsh vole and the Alabama, Perdido Key, and other beach mice, which occupy coastal habitats in the Eastern Gulf of Mexico, would be negligible. Eliminating these deepwater activities by adopting alternative 3 would not change this minimal level of impact to these mice.

If alternative 3 were adopted, impacts to marine and coastal birds would be negligible in the Eastern Gulf. The birds most likely to benefit from this alternative are those that concentrate in Alabama shoreline habitat (for feeding or nesting) such as the brown pelican, gulls, terns, shore birds, and waterfowl. Overall impacts to marine and coastal birds in the Gulf of Mexico from routine activities, primarily entanglement with debris and helicopter and service vessel traffic, are predicted to be minor, as for the proposal. Because the risk of oil spills from activities in the Central and Western Gulf is the same for alternative 3 and the proposal, the potential impact of alternative 3 to marine and coastal birds from spills would be the same as the proposal, minor to moderate.

The impacts to most other biological resources in the Eastern Gulf of Mexico, including fish, EFH (prey species, water, and substrate), sea turtles, and coastal resources such as beaches and wetlands, would be reduced somewhat or eliminated by alternative 3. Gulf sturgeon move from coastal rivers into inner shelf waters of the eastern and central Gulf during cooler months to feed. During this time, possible pipeline spills are the only event likely to affect Gulf sturgeon. Excluding the Eastern Gulf of Mexico from leasing reduces the potential for a shallow water pipeline spill to impact the sturgeon. Sea turtles occur throughout the Gulf in different environments at different life stages. This alternative would eliminate impacts to sea turtles locally, especially on nesting beaches. Potential impacts to these resources overall in the Gulf of Mexico would be at the same level as for the proposed action.

Live bottom areas are located primarily on the continental shelf offshore west Florida, and most of the seagrass beds in the Gulf of Mexico are located off the coast of Florida. If alternative 3 were adopted, the primary threat to these resources from oil and gas activities and potential spills in the Eastern Gulf would be eliminated, and the overall impact level is expected to be negligible. The impact from the proposal is expected to be minor. Impacts to other seafloor habitats, specifically, the pinnacle trend and chemosynthetic communities, would still be susceptible to impacts from activities in the Central and Western Gulf of Mexico Planning Areas. Therefore, if alternative 3 were adopted, impacts to these resources would still be minor overall.

The proposed action poses a minimal risk to parks, refuges, and reserves along the west coast of Florida, and to the Florida Keys National Marine Sanctuary because the Eastern Gulf of Mexico program area is far from shore and at the western extreme of the Eastern Gulf of Mexico Planning Area. Therefore, adopting alternative 3 is not expected to result in any difference in potential impacts to these special areas. Potential impacts to areas of special concern elsewhere in the Central Gulf of Mexico, such as the Gulf Islands National Seashore, could be slightly less than the proposal because of reduced impacts from nearshore pipeline spills. Overall, the impact would be negligible to minor from routine activities and minor to moderate from oil spills, which is the same as the proposal.

If alternative 3 were adopted, the potential impacts to population, employment, regional income, land use, existing infrastructure, and archaeological resources would be somewhat less in Florida than impacts from the proposal, but the overall impact level will remain the same. Onshore infrastructure is located in the Central and Western Gulf, where most of the socioeconomic impacts would occur. Eliminating sales in the Eastern Gulf would not change these impact levels. Because the program area in the Eastern Gulf for the proposal is 100 miles or more from the Florida coast, there would be no measurable difference in impacts to tourism and recreation in Florida if alternative 3 were adopted. Overall impacts to tourism and recreation throughout the Gulf of Mexico under this alternative would be the same as the proposal.

In summary, if alternative 3 were adopted, the impacts to most resources would be reduced or in some cases eliminated in the Eastern Gulf of Mexico Planning Area, but impacts to those resources in the Central and Western Gulf of Mexico Planning Areas would be essentially the same as the impacts of the proposed action.

4.5.3. Alaska Region

Although there will be no sales in the Hope Basin or Norton Basin if alternative 3 were adopted, leasing would be conducted in the Beaufort Sea, Chukchi Sea, and Cook Inlet, and the anticipated oil and gas activity in those three planning areas would be the same as for the proposal. None of the impacts predicted for alternative 1 as a result of sales conducted in Hope Basin or Norton Basin would occur if alternative 3 were adopted.

If an oil spill were to occur in the southern portion of the Chukchi Sea, it is possible that under certain conditions some of the oil could enter Hope Basin and affect marine and coastal resources. However, the nearshore surface currents in the Chukchi Sea (Figure 3-25) would more likely move the oil to the north. Any possibility of oil spills, air emissions, or drilling discharges from oil and gas activity in Hope Basin affecting Cape Krusenstern National Monument or the Bering Land Bridge National Preserve (Figure 3-31) would be eliminated.

In general, only a minimal level of activity would be expected in Norton Basin and Hope Basin if sales were conducted as indicated in the proposed action. Only natural gas is expected to be produced for local consumption. Because no oil production is anticipated in these two areas, there is no risk of oil spills, which is the major environmental concern associated with OCS activity. Consequently, while alternative 3 reduces or eliminates impacts to all affected resources locally in Norton Basin and Hope Basin, the impacts overall to these resources throughout Alaska would be at the levels described for the proposed action.

4.5.4. Pacific Region

The only threat to resources along the Pacific coast from the proposed program would be from the transportation of OCS oil from the port of Valdez to west coast ports. However, all the OCS oil estimated to be transported to Valdez through the Trans-Alaska Pipeline System (TAPS) would originate from the Beaufort and Chukchi Seas. As a result, if alternative 3 were adopted, the amount of OCS oil transported from Valdez, and the number of spills that could occur from tankers carrying that oil to west coast ports, would be the same as the proposal. Therefore, adoption of this alternative could result in impacts to environmental resources in the Pacific Region similar to impacts from the proposal. The nature and severity of these impacts would be the same as those described for the proposed action.

4.6. Environmental Impacts of Alternative 4—Accelerated Leasing

4.6.1. Scenario

Alternative 4 would hold 25 sales in eight planning areas (Tables 4-4a and b). The pace of leasing would be greater in the Eastern Gulf of Mexico and Beaufort Sea Planning Areas because more sales would be offered than for alternative 1 (the proposed action). There would be three sales rather than two in the Eastern Gulf of Mexico and five sales rather than three in the Beaufort Sea.

Anticipated production values for alternative 4 are presented in Tables 4-4a and b. The amount of hydrocarbons anticipated to be produced would be greater than for the proposal for the Eastern Gulf of Mexico and the Beaufort Sea because there would be more sales in those planning areas. The levels of offshore and onshore oil and gas activities are based on the amount of hydrocarbons expected to be leased, developed, and produced as a result of the sales. Therefore, there will be somewhat greater activity in these two planning areas for this alternative (Tables 4-4a and b) than for the proposed action (Table 4-1a and b). The same means of transporting hydrocarbons to shore from production facilities would be used for alternatives 1 and 4.

Table 4-4c presents the number of oil spills assumed to occur and the probability of spill occurrence as a result of OCS activity associated with alternative 4. It is assumed that these spills would occur with uniform frequency over the life of the OCS activities resulting from this alternative. It is also assumed that the number of spills from import tankers would decrease slightly in the Gulf of Mexico and on the west coast because some of the imported oil would be replaced by the oil and gas produced as a result of the additional sale.

4.6.2. Gulf of Mexico Region

This alternative would add a third sale during the 2002-2007 period in the Eastern Gulf of Mexico Planning Area. The area considered for lease would be the same area considered for the two sales in the proposal. There would be no change in the Central and Western Gulf of Mexico Planning Areas where sales would be held annually. A third sale in the Eastern Gulf of Mexico is expected to result in the production of additional oil and gas resources (Table 4-4a). There would be a corresponding increase in the level of exploration, development, and production activity in the Eastern Gulf and support facilities in the Central Gulf.

The increase in OCS activities in the Eastern Gulf will similarly increase the level of various types of disturbance, effluents and emissions, sedimentation, noise, and other impact agents described in alternative 1. Tables 4-4a and c list the range of activities and oil spill assumptions, respectively, for alternative 4. The activities potentially causing impacts are the same for both alternatives, and impact levels for many resources cannot be differentiated for the affected resources, either at the local or regional level, based on the slight differences in levels of activity in the Eastern Gulf estimated at this programmatic stage. Overall, if the same number of sales were conducted in the Central and Western Gulf of Mexico but one additional sale were held in the Eastern Gulf, it is expected that the overall impact levels for all affected resources would be the same as those predicted for the proposed action.

All oil produced in the Eastern Gulf program area is assumed to be transported via pipeline to existing or projected facilities in the Central Gulf of Mexico Planning Area. It is assumed that all produced gas would be transported via pipeline to shore. three sales were held in the Eastern Gulf program area, up to three new gas pipeline landfalls could result and possibly one or two new pipeline shore facilities could be built in Louisiana or Alabama.

Pipeline landfalls and construction of pipeline shore facilities in Alabama should have minimal impacts on wetlands due to State regulatory requirements. Pipelines installed in Louisiana could cause localized impacts to wetlands. Effective mitigation could reduce these wetland losses. Overall, impacts to coastal resources, including wetlands, in the Gulf will be minor from routine operations and minor to moderate if a large oil spill should occur nearshore and contact wetlands. These are the same impact levels as the proposal.

Little impact to submerged vegetation from the installation of additional pipelines is predicted because of Federal and State requirements that pipeline routes avoid submerged vegetation beds. Impacts from routine activities is likely to be minor, the same as the proposal. Oil spills pose the greatest threat to submerged aquatic vegetation. Considering the assumed number of oil spills for this alternative, the overall impact to submerged seagrass beds generally is predicted to be the same as the proposal, minor to moderate if a large nearshore spill were to contact submerged vegetation.

There would be very little, if any, economic stimulus to the Florida Panhandle region whether the proposal or alternative 4 were adopted. The impacts on population, employment, and regional income in the Gulf of Mexico Region are predicted to be minor for alternative 4, the same as the proposal.

In summary, impacts could be somewhat greater locally for the following resources if alternative 4 were adopted:

- water quality
- marine mammals
- fish resources
- sea turtles
- essential fish habitat
- commercial and recreational fisheries

Although impacts may increase somewhat along the border of the Central and Eastern Gulf of Mexico Planning areas if alternative 4 were adopted, the impact levels would be the same as for the proposed action for the Gulf of Mexico Region overall.

4.6.3. Alaska Region

This alternative would add two sales in the Beaufort Sea Planning Area during the 2002-2007 period. The area considered for lease would be the same area considered for the three sales in the proposal. There would be no change in the number of sales or the configuration of the program areas for the other Alaska planning areas. Additional sales in the Beaufort Sea are expected to result in the production of additional oil and gas resources (Table 4-4b) and a corresponding increase in the level of exploration, development, and production activity.

The increase in OCS activities in the Beaufort Sea will similarly increase the level of various types of disturbance, effluents and emissions, sedimentation, noise, and other impact agents described in alternative 1. Tables 4-4b and c list the range of activities and oil-spill assumptions, respectively, for alternative 4. It is assumed that much of the onshore infrastructure needed to support activities resulting from the two additional sales in the Beaufort Sea will already be in place because of existing and projected offshore activities in the planning area.

Additional sales in the Beaufort Sea are likely to extend exploration, development, and production activities into deeper waters. As a result, migrating bowhead whales may be affected by an increase in noise disturbance associated with routine activities at platforms further from shore. While impacts of the proposed action to the bowhead whale are expected to be minor to moderate, impacts from alternative 4 are predicted to be moderate because of this increase in noise disturbance. Impacts to all other cetaceans are expected to remain negligible to minor, the same as for the proposed action.

Of the pinniped species present in the Beaufort Sea Planning Area, ringed and bearded seals would be expected to exhibit the most discernible increase in local impacts due to routine aircraft activity, icebreaking activities, and drillship operations. However, impacts to pinnipeds are not expected to exceed the minor level. Denning polar bears would most likely experience increased impacts from noise associated with on-ice vehicle traffic and ice road construction. Noise mitigation would be necessary to maintain impacts to denning bears at a moderate level. The difference in potential impacts to marine mammals from additional oil spills expected from alternative 4 would only be evident if multiple spills were to occur back-to-back without recovery events.

Two more sales would likely result in some increase in the miles of offshore pipelines in the Beaufort Sea as well as an additional pipeline landfall. These activities could increase impacts at the local level to seafloor habitats and benthic organisms, especially the Stefansson Sound Boulder Patch community where impacts could range from minor to major.

Conducting annual sales in the Beaufort Sea for the 2002-2007 period could have potentially major effects on sociocultural systems in the region. Resistance to increased operations among local subsistence harvesters would result in conflict among industry, government, and local people that may have prolonged impacts.

Additional activity in the Beaufort Sea Planning Area will lead to somewhat higher incomes for workers in the oil and gas industry. A sizeable portion of this workforce lives in south-central Alaska. Therefore, there could be a slight increase in recreational activities in the Cook Inlet and Gulf of Alaska areas. However, the level of impact on tourism and recreation is expected to remain minor to moderate overall.

The two additional Beaufort Sea sales will probably serve to retard the decline in the oil and gas sector rather than lead to growth in the overall State economy. Although the level of activity expected from alternative 4 influences the most important sector in the Alaska economy, the effect will be sufficiently weak that overall impacts on population, employment, and regional income will remain minor.

A primary effect of conducting annual sales in the Beaufort Sea may be on local and State agencies that participate in the leasing process. To mitigate this effect, the Minerals Mangement Service (MMS) is instituting a process that combines many of the key steps in the leasing process rather than repeating each step for every sale. However, sales would be held annually in the Beaufort Sea if alternative 4 were adopted, and this would impose a greater administrative burden on local and State agencies in spite of efforts to streamline the process.

In summary, if sales were conducted annually in the Beaufort Sea, the impacts would be somewhat greater locally for the following resources:

- water quality
- marine mammals
- terrestrial mammals
- marine and coastal birds
- fish resources and essential fish habitat
- coastal habitats
- seafloor habitats
- parks, reserves, and refuges

- population, employment, and regional income
- land use and existing infrastructure
- sociocultural systems and environmental justice

The activities potentially causing impacts are the same in all five Alaska planning areas for alternatives 1 and 4, and impacts cannot be differentiated outside the Beaufort Sea for most of the affected resources, either at the local or regional level, based on the differences in levels of activity estimated at this programmatic stage. Overall, if sales were held annually in the Beaufort Sea, it is expected that the overall impact levels for most affected resources would be the same as those predicted for the proposed action. However, impacts for two resources are expected to increase. The increase in noise disturbance from routine activities could cause moderate impacts to the bowhead whale. The additional sales in the Beaufort Sea are likely to have major effects on sociocultural systems on the North Slope.

4.6.4. Pacific Region

The only threat to resources along the Pacific coast from the proposed program would be from the transportation of OCS oil from the port of Valdez to west coast ports. All the OCS oil estimated to be transported to Valdez through TAPS would originate from the Beaufort and Chukchi Sea Planning Areas. As a result, if alternative 4 were adopted, the amount of OCS oil transported from Valdez is estimated to increase, and the number of spills that could occur from tankers carrying that oil to west coast ports could increase as well. Adopting this alternative could result in impacts to environmental resources in the Pacific Region similar to impacts from the proposal. Their nature and severity are expected to be the same as those described for the proposed action.

4.7. Environmental Impacts of Alternative 5—No Action

The no action alternative corresponds to a situation where the U.S. Department of the Interior (USDOI) does not adopt the proposed action in the 5-year program for 2002-2007 or any other active OCS leasing schedule for the 2002-2007 period. Thus, no oil and natural gas would be produced from this program. The amount of oil and natural gas forgone is shown in Table 4-5c.

Under the no action alternative, none of the environmental impacts associated with the proposed action, as described in Section 4.3., would occur. The proposed action also would not contribute to cumulative effects; however, the effects from other activities would still occur.

The impacts of the proposed action on employment, regional income, and the sociocultural stability of regions also would not occur under the no action alternative. However, unlike the natural environment, the human environment, especially in the Gulf of Mexico, might experience direct negative effects from no action. The offshore oil and natural gas industry operates on a continuing stream of new leases that are explored and developed over time. If a 5-year interruption were to occur in the leasing process, this interruption would inevitably lead to a disruption in the normal development sequence. It is very difficult to estimate with any degree of accuracy how a regional economy will react to a loss of employment and income in one sector. Nevertheless, it is safe to say that the net effect of an economic loss of the type represented by the no action alternative would have a measurable impact on the regional economies involved. Substitutes for OCS oil and natural gas will also create regional socioeconomic impacts of varying degrees. Where those impacts are expected to be of consequence, they are addressed in the appropriate sections below.

Failure to implement the proposed action would force the economy to substitute energy from alternative sources for the resulting lower production of OCS oil and natural gas. The next section lists the uses of oil, natural gas, and natural gas liquids. Following that is a section that identifies the most likely sources of alternative energy to meet the demand for those uses. This section is followed by an analysis of the environmental impacts associated with these alternative energy sources.[1] The final section discusses energy alternatives that government may impose.

4.7.1. Uses for Oil, Natural Gas, and Natural Gas Liquids

The first step in determining which sources of energy will replace lost OCS production is to identify the uses of the oil, natural gas, and natural gas liquids (NGL's) produced on the OCS. Natural gas liquids are liquids removed from streams of natural gas production that are similar to and used in similar ways to the lighter fractions of crude oil.

4.7.1.1. Oil and NGL's

The MMS identified and considered the following uses for oil and NGL's in the U.S. economy:

- transportation vehicle and machinery fuel
  - gasoline powered cars, light trucks and buses, boats, aircraft, tractors, and small engines
  - diesel powered cars, trucks, buses, trains, boats, tractors, and machinery
  - jet aircraft
  - steam powered ships
  - propane powered industrial vehicles
- industrial sector uses
  - industrial process heat and steam
  - drying and interior space heating and cooling
  - cogeneration
- residential and commercial sector uses
  - interior space heating and cooling
  - hot water
  - appliances
- electricity generation
  - steam boilers
  - diesel generators
- nonenergy uses
  - chemical feedstock
  - solvents, lubricants, asphalts, and waxes

Table 4-5a provides statistics on quantities and percentages of oil-based products used in each energy category or sector. As the table shows, oil provides about 39 percent of our energy on a Btu basis. It dominates transportation to such an extent that it can be said that U.S. transportation runs on oil. Oil is an important, but not dominant, source of energy to industry. It makes a modest contribution to the residential and commercial sector and only a minor contribution in electricity generation.

[1]The discussion of energy alternatives under the no action alternative is based on material in "Energy Alternatives and the Environment" (King, 2001) available from the Publications Section, Minerals Management Service.

4.7.1.2. Natural Gas

The MMS identified and considered the following uses for natural gas in the U.S. economy:

- electricity generation
  - steam boilers
  - turbines
  - combined cycle
- industrial sector uses
  - industrial process heat and steam
  - drying and interior space heating and cooling
  - cogeneration
- residential and commercial sector uses
  - interior space heating and cooling
  - hot water
  - appliances
- transportation vehicle fuel

As Table 4-5b shows, the industrial sector is the number one consumer of natural gas followed closely by the residential and commercial sectors. Electricity generation uses less than half as much gas as the preceding sectors; however, it is the fastest growing major use of natural gas. The figure shown for transportation refers only to the use of natural gas in pipeline transportation.

4.7.2. The Most Likely Alternative Energy Mix and Its Impacts

Table 4-5c identifies the "most likely" set of energy alternatives that the economy would adopt in response to the no action alternative. The estimates in this table were generated using MarketSim2000, a model developed to analyze energy alternatives and other economic aspects of the 5-year program. The model and the estimates in the table assume that basic economic decisions in the U.S. economy will continue to be made through the free market system. The Federal Government might also impose certain energy alternatives on the economy to accomplish various political and environmental goals. Alternatives that might be imposed by the Government are discussed in Section 4.7.3. and at greater length in King (2001).

In Table 4-5c, all of the numbers are in relation to the production assumed to occur as a result of the proposed action but lost in the no action alternative. Focussing first on oil production, in the low price case the overwhelming percentage (86%) of lost OCS production will be made up by importing oil. Smaller percentages will be substituted by conservation (7% on an energy equivalent basis), increased onshore production (3%), and switching to natural gas (5% on an energy equivalent basis).

In the low price case, the market will substitute about 26 percent of lost OCS gas production with onshore gas, about 42 percent on an energy equivalent basis by switching to oil, about 17 percent on an energy equivalent basis with conservation, and about 16 percent with imports. In assessing the process of substituting oil for lost OCS gas, MMS assumes that the percent of additional oil the economy obtains through imports is the same as the percentage calculated for the case of lost OCS oil (86%). As a result, the switch from natural gas to oil will induce additional imports of between 0.6 and 1.1 billion barrels of oil over 40 years.

As stated in the introduction to this section, none of the negative environmental impacts and risks associated with the proposed action (including incremental contributions to the cumulative case) would occur under the no action alternative. However, the energy alternatives substituted for the lost OCS production would have negative impacts of their own.

4.7.2.1. Replacements for OCS Oil and NGL's

4.7.2.1.1. Increased Oil Imports

Table 4-5c shows a significant increase in U.S. imports of crude oil as a result of the no action alternative. These additional imports both replace a portion of the decreased OCS oil production and respond to fuel switching to oil occasioned by the decrease in OCS natural gas production. An insignificant amount of additional employment related to additional imports would probably occur in and around ports and in the transportation sector as imported oil moves to refineries. Available models probably could not measure the overall effect on regional economies and regional social stability from additional imports.

The additional crude oil imports associated with the no action alternative increase the risk of large oil spills. Table 4-5d shows the estimated additional spills greater than 1,000 barrels (bbl), along with their probabilities, associated with the no action alternative. These spills are expected to lead to the most significant negative environmental impacts associated with the no action alternative. Other significant environmental impacts associated with the expanded importation of oil include:

- generation of greenhouse gases and regulated air pollutants from both transport and dockside - activities (emissions of nitrogen oxide [NO_x, sulfur oxide, and volatile organic compounds having an impact on acid rain, tropospheric ozone formation, and stratospheric ozone depletion)
- degradation of water quality in the instances of oil spills from either accidental or intentional discharges or tanker casualties
- possible destruction of flora and fauna and recreational and scenic land and water areas in the instance of oil spills
- public fear of the increased likelihood of oil spills

Citizens are concerned about the oil spills associated with imports. Imported oil is the single largest component in the replacement mix, consisting of 86 percent of the lost oil and 36 percent (42% x 86% = 36%) of the lost natural gas on an energy equivalent basis. Therefore, the environmental impact analysis of the no action alternative focuses on oil importation.

Large oil spills resulting from additional imports associated with the no action alternative are expected to lead to the region-specific impacts described below.

Gulf of Mexico Region

The no action alternative will eliminate all lease sales (12) in the Gulf of Mexico proposed for the 5-year program for 2002-2007. The elimination of lease sales in the Gulf of Mexico would eliminate all impacts, positive and negative, associated with the proposed action (alternative 1). The incremental contribution of the proposed action to cumulative effects would also be eliminated, but such effects from other activities, including past lease sales and potential future OCS program activities, would remain. It is assumed that most of the replacement energy will be from imported oil. Table 4-5d presents the number of large spills associated with the no action alternative and the probability of occurrence. It is estimated that about half the number of large oil spills estimated for alternative 1 would occur in the Gulf of Mexico if the no action alternative were adopted. The source of large spills changes considerably. For the proposed action, the primary spill source was pipelines

(66%) followed by platform spills (25%), with tanker spills playing a minor role (6%). All spills, as a result of the no action alternative, would result from tankers since almost all replacement oil would be imported.

The source of spills is important when considering the risk to coastal areas within the Gulf of Mexico. The size of the spills and the most likely locations of the spills are important factors as well. Platform spills normally occur farther from coastal areas than tanker spills, although OCS pipeline spills have occurred more frequently closer to the shoreline where anchor damage can occur more easily. However, the average tanker spill is twice the size of the average OCS pipeline spill. Several very large tanker spills have occurred in the Gulf area (the *Mega Borg*, 93,000 bbl; *Burmah Agate*, 248,000 bbl; and the *Ocean 255* barge, 231,000 bbl), two of which were similar to the *Exxon Valdez* (241,000 bbl) in size.

If alternative 5 (no action) were adopted, the principal cause of impacts would be from coastal tanker spills. The increased risk of large spills would increase somewhat the severity of impacts on the following resources:

- marine or coastal birds
- marine turtles
- estuarine-dependent fish species
- commercial and recreational fishing
- beach recreation and related tourism

Furthermore, wetland losses could be twice the amount estimated for the proposed action. The employment estimated to result from the proposal would not occur, nor would the resulting in-migration.

On the other hand, the no action alternative would result in a decreased risk to topographic features and live bottoms from oil spills and installation of drilling rigs, platforms, and pipelines.

Alaska Region

The proposed action includes sales in five Alaska planning areas: the Beaufort Sea, Chukchi Sea, Hope Basin, Norton Basin, and Cook Inlet. It is assumed that tankers to west coast ports would transport any oil produced from these areas, with the exception of Norton Basin and Cook Inlet. Norton Basin and Hope Basin are not expected to have any oil production, and about one-third of the oil produced in Cook Inlet would be refined at Nikiski.

If the no action alternative were adopted, some of the oil that would have been produced from sales in all Alaska planning areas (including two thirds of Cook Inlet production) will be replaced by foreign imports. It is assumed that tankers would transport these imports to west coast ports. Therefore, the no action alternative would eliminate the potential impacts from the proposal that could occur in the Alaska Region other than Cook Inlet (Section 4.3.3.). Specifically, none of the impacts of exploration, development, and production activities described for the proposal would occur in Alaska waters or in Alaska coastal areas (except Cook Inlet). No wells would be drilled, and no oil or gas would be produced and transported; therefore, no oil spills could occur from proposal-related OCS activities that could adversely affect environmental resources.

Oil that would have been produced from the Cook Inlet sale and refined in Nikiski would most likely be replaced by additional oil from the Port of Valdez if the no action alternative were adopted. There is a 7-12 percent probability that an oil spill of 1,000 bbl or more would occur from these additional tankers (Table 4-5d). The potential impacts of a large tanker spill to resources in the Gulf of Alaska and Cook Inlet are described in the analysis of the proposal (Section 4.3.3.).

Pacific Region

Section 4.3.4. describes the potential impacts to environmental resources in the Pacific Region that could occur from activities resulting from the proposed action. Because no sales are proposed in the Pacific Region, the only impacts that could occur on the west coast would be the result of oil spills from tankers transporting oil from the Alaska Region to west coast ports. In the proposed action, it is estimated that as many as two tanker spills of 1,000 bbl or more could occur anywhere along the tanker route from the Port of Valdez to west coast ports. It is assumed that these spills could occur in Alaskan waters or in the Pacific Region.

The risk of these tanker spills is eliminated if the no action alternative were adopted. However, it is estimated that some of the oil that would have been produced from the sales proposed on the Alaska OCS will be replaced by imported oil. Based on the additional oil that would be imported, the risk of a tanker spill occurring in the Pacific Region is almost as great for the no action alternative as it is for the proposed action.

4.7.2.1.2. Domestic Onshore Oil Production

The greatest potential for significantly increasing the domestic crude oil supply lies with the successful application of enhanced oil recovery (EOR) processes to known reservoirs, and by additional drilling in existing fields (infill drilling). The EOR processes include chemical flooding, miscible flooding, and thermal recovery methods. A key feature common to all three methods is the need to inject liquids or gases to mobilize and displace otherwise unrecoverable oil. The EOR activities do not usually impose significant additional negative impacts in areas where primary and secondary recovery have already occurred.

The major environmental impacts associated with expanded domestic onshore oil production using EOR techniques include potential degradation of local ambient air quality from atmospheric emissions of dust, engine exhaust, off-well gases, gas flaring products, particulates, sulfur dioxide, carbon monoxide, NO_x, hydrogen sulfide, and hydrocarbons. These releases can lead to acid deposition, increase in tropospheric ozone, depletion of stratospheric ozone, and potential degradation of local and national air quality due to emissions of greenhouse gases, especially carbon dioxide used in miscible flooding. Additional impacts could include:

- possible degradation of both surface water and groundwater quality from spills or leaks of process chemicals during handling, mixing, or injection
- increased potential for chemical contamination of drinking water by injected fluids left in the reservoir
- expanded land use through more intensive field development, (i.e., more wells, roads, injection lines, and facilities)

Finally, workers may face health risks from the handling of the toxic chemicals used in thermal and chemical recovery processes.

Additional domestic onshore oil exploration, development, and production occasioned by the decrease in OCS activity would employ some of the workers displaced from the offshore industry.

This would tend to ameliorate some of the negative impacts on regional employment, income, and social stability. However, much of the additional employment would occur outside the normal OCS service areas. This would mean that either job opportunities would be unavailable to the displaced workers, or it would tend to lead to community instability as families are uprooted or torn apart as workers leave their homes for employment opportunities in other regions.

4.7.2.1.3. Conservation

Oil conservation efforts would likely focus on the transportation and industrial sectors. Transportation sector conservation may take the form of increased fuel economy (e.g., driving more fuel efficient vehicles, driving smaller and lighter cars, driving at slower speeds, and replacing gasoline engines with diesel engines or hybrid gas-electric systems) or reduced miles traveled by private vehicles through use of public transportation. These transportation-related measures should have positive net impacts on the environment.

A major industrial end use of oil and NGL's is as a feedstock for plastics. Thus, reduced consumption of plastics is an alternative to oil (or NGL) production. However, other impacts may be associated with production and use of the substitute materials. For example, substituting steel for some plastic parts in automobiles could lead to greater energy consumption and possibly greater attendant environmental impacts (steel production requires coal production; steel adds weight to a vehicle, thus making it less fuel efficient and leading to increased oil production or imports). Thus, reducing plastic consumption may not lead to reduced environmental impacts.

Oil conservation is unlikely to have any measurable effect on regional employment, income, or social stability.

4.7.2.1.4. Switching to Gas

Environmental impacts associated with increased domestic onshore gas production are discussed later in Section 4.7.2.2.1.

4.7.2.2. Replacements for OCS Natural Gas

4.7.2.2.1. Domestic Onshore Gas Production

Increased domestic onshore gas production represents 26 percent of the replacement for OCS natural gas produced under the proposed action. Following are the major negative environmental impacts associated with increased domestic onshore gas production:

- Noise and regulated pollutant emissions result from support equipment and from venting and flaring of natural gas during excavation and initial production. These emissions contribute to greenhouse gases, potentially add to acid rain and tropospheric ozone, and may have a negative impact on stratospheric ozone.
- Discharge of produced water, which is elevated in salts, trace metals, solids, etc., can degrade surface and groundwater quality and uses. Hydraulic fracturing may result in disruption and potential contamination of aquifers.
- Land disturbance occurs from site preparation at drilling locations (typically 3 acres are cleared, graded, and leveled per deep-well location) and establishment of holding ponds for wastes like drill muds and cuttings. These activities result in soil erosion, vegetation destruction, ecosystem disturbance, and potential effects on wetlands.

- For the most part, economic and social impacts from additional onshore gas production will add to but be indistinguishable from those associated with additional onshore oil production. However, workers will face increased risk of exposure to toxic chemicals in the fracturing fluids that are used more extensively in gas production.
- Onshore gas development could result in the direct physical contact between the construction of new gas facilities or pipelines and previously unidentified archaeological resources. State and Federal laws require consideration of archaeological resources if any State or Federal funding or permits are required for construction. Therefore, impacts to historic or prehistoric sites from onshore gas development would be unlikely.

4.7.2.2.2. Switching to Oil

Almost all the additional oil consumed because of switching from natural gas to oil would come from imports. Environmental impacts associated with oil imports were discussed in Section 4.7.2.1.1.

4.7.2.2.3. Conservation

Reduced gas consumption would not produce air, water, or land impacts or generate any solid waste and, thus, would have zero negative environmental impacts.

4.7.2.2.4. Gas Imports

Most additional gas imports would come via pipelines from Canada. New pipelines would be needed, and these would have impacts on the lands through which they passed. Additional gas imports also may come by ship in the form of liquefied natural gas (LNG). The only major environmental impacts associated with expanded LNG importation might occur if a LNG carrying tank were to puncture or leak during unloading. Because LNG readily vaporizes but does not disperse quickly and remains near ground level, accidental ignition of the vapor clouds would have tremendous explosive power. Regulated pollutant emissions during transport and unloading are not a significant problem due to the ship's special combustion system, the use of natural gas as fuel in the process, and the special unloading process.

4.7.3. Government Imposed Alternatives and Their Impacts

The U.S. Government or the governments of States like California or those in the Northeast might choose to encourage or mandate use of one or more energy alternatives different from those chosen by the market. Mechanisms that might be used are taxes like a carbon tax or vehicle fuel taxes, an integrated energy conservation program, or more specific mandated energy saving measures. Among the energy saving measures that governments might mandate are automobile fuel economy standards and the requirement in California and portions of the Northeast that a certain percentage of new vehicles sold after a given date be zero emission vehicles. King (2001) discusses mechanisms for imposing alternatives at greater length; however, regardless of the mechanism chosen, it must operate through an energy alternative such as those examined below.

The most-likely targets for government action would be vehicle fuels and fuel consumption and electricity generation plants, their fuels, and electricity consumption. Narrowly focussed measures are more likely than broad measures, and the choice of target probably will be tied in to environmental considerations, especially air pollution minimization.

The phrase "energy conservation" can be useful in certain contexts. Unfortunately, as the discussion becomes more specific in terms of energy alternatives, energy conservation can come to mean many different things. For instance, energy conservation has been used to describe each of the following types of alternatives:

- saving a fuel like gasoline by switching to an alternative like ethanol or methanol
- improving the use of a fuel through more efficient production of the energy product such as improving automobile fuel economy or power plant efficiency
- enhancing the efficiency of an energy-related transportation system by means such as providing more mass transit or improving electricity transmission
- encouraging consumers to use less of the energy product through actions such as work-at-home or turning down thermostats

This section will follow the convention that fuel switching is not energy conservation. The other three categories above can be classed as conservation; however, most of the remainder of this section will keep the three types of alternatives separate. In addition, the major focus of the rest of this section will be on vehicle fuels and electricity generation with only passing reference to industrial, residential, and commercial energy alternatives.

4.7.3.1. Transportation Vehicle Fuels

4.7.3.1.1. Fuel Switching

Ethanol

Ethanol as an alternative to gasoline or diesel fuel will require additional production of some biological product. Corn is the feedstock most widely used for ethanol production in North America. Energy experts expect corn to serve as the feedstock of choice for additional future ethanol production. Additional corn will probably be grown principally on land now considered marginal for crop production. This will mean taking land out of less intense uses to devote to this intensively cultivated row crop. The result will be significant increases in soil erosion, fertilizer runoff, and systemic effects through expanded uses of pesticides and herbicides in the case of no-till cultivation. The net effect will be deteriorated water quality through siltation, eutrophication, and chemical toxicity. Upland wildlife habitat will be diminished through loss of cover and the effects of chemical toxicity. Wildlife will also be adversely affected by the additional rural activity associated with the more intense agriculture. Production of ethanol uses great quantities of water and leads to releases of large quantities of oxygen depleting materials into streams and rivers. The net effect is significant further deterioration of water quality. Ethanol production also has deleterious impacts on local air quality through releases of hydrocarbons and on greenhouse gases through release of large quantities of CO_2. Increased ethanol production would have positive impacts on the economies of corn producing areas, but these might be somewhat offset by the negative impacts on noncorn producing areas where food prices would increase marginally.

Natural Gas

Natural gas vehicles have the potential to replace a large percentage of the urban fleet vehicles currently operating on gasoline. The environmental impacts of domestic onshore production of natural gas are discussed in Section 4.7.2.2.1.

Hydrogen

Hydrogen-powered fuel cells could be used in a new generation of vehicles designed to minimize final-use air pollution in urban areas. Fuel cell cars would emit only water vapor. However, this technology faces three major impediments:

- production of hydrogen using present technology is an expensive proposition requiring large amounts of electricity
- no distribution network exists for hydrogen
- it is relatively difficult to transport hydrogen over long distances

The present administration has announced a program to pursue hydrogen fuel cell vehicle research. If this program is successful on a large scale, major additions to the electricity production infrastructure would have to be developed. The impacts of this development are discussed in Section 4.7.3.2. Hydrogen is an entirely new fuel, and the development of the new industry would undoubtedly provide employment opportunities and increased income to the regional economies in locations where the new industry was located.

Electricity

Substantial adoption of electric vehicles, which have no final use emissions, would greatly increase the demand for electricity. Meeting increased demand for electricity would lead to the kinds of environmental impacts noted in Section 4.7.3.2.

4.7.3.1.2. More Efficient Vehicles

More Efficient Engines and Transmissions

The automotive industry faces a formidable challenge in trying to maintain performance standards with engines and transmissions that use less fuel without greatly increasing the cost of these major vehicle components. Assuming the automotive firms can find a solution acceptable to the government and consumers, the environmental impacts associated with the production of such machinery would probably be indistinguishable from those associated with less-fuel-efficient components.

Lighter, More Streamlined Bodies

The other way to produce more efficient vehicles besides more efficient engines and transmissions is to build them with lighter, more streamlined bodies. Once again, the industry is faced with maintaining safety standards and holding down costs while improving the efficiency of vehicle bodies. Lighter bodies may entail more use of plastics in place of steel, although the steel industry has recently unveiled a newly designed lighter prototype car body. Regardless of what materials are used, the environmental impacts associated with their production will probably be comparable with similar quantities of present auto body parts.

4.7.3.1.3. More Efficient Transportation Systems

More Mass Transit

If governments could get people out of their cars and into mass transit, including car pools, that action would ameliorate a significant array of the problems associated with our urban transportation systems. The environmental impacts of such a behavioral shift would be very positive. Air, water, land, noise, and visual aesthetics would all be improved.

More Rail

Rail transportation of goods is much more fuel efficient than movement by truck. A significant switch from truck to rail would also lead to environmental improvement. Impacts to air, water, land, and noise would all decline.

4.7.3.1.4. Less Motorized Transportation

Telecommuting and the use of nonmotorized transportation, such as bicycles and walking, would have similar but greater positive impacts on the environment as mass transit.

4.7.3.2. Electricity Generation

4.7.3.2.1. Alternative Fuels

Coal

Coal extraction is almost synonymous with negative environmental impacts. It causes especially severe impacts on water resources, which are degraded by acidic drainage from active and abandoned mines and by silt from earth movement which is especially serious in mountain top, strip, and auger mining. Ground water is often polluted or disrupted by coal extraction because coal seams serve as the aquifer in many locations. Coal mining also is associated with air pollution from dust and machinery exhaust. The machinery also produces noise pollution. The impact of coal extraction on visual aesthetics is especially severe because the surface scars from strip mining and the mountainside cuts from auger mining have an especially significant effect on scenic mountain areas. Additional demand for coal would provide employment opportunities in many traditionally underemployed coal mining areas.

Nuclear

Compared with other forms of large-scale electricity generation, nuclear power has demonstrated relatively minor environmental impacts. Mine tailings from uranium mining have caused radioactive water pollution in the West, but this is more a result of formerly inadequate regulation or lax enforcement than it is a problem with present production. The tremendous cooling needs of nuclear reactors can lead to abnormal temperature increases in bodies of water used for plant cooling. The size of the containment vessels can also cause visual aesthetic degradation. Nuclear power faces two major impediments to its future success. The first is the risk of catastrophic failure of a nuclear plant with large-scale nuclear contamination of surrounding areas. The second entails finding socially acceptable, long-term repositories for the spent fuel rods that are removed from these plants.

Hydroelectric

Most attractive hydroelectric sites in the United States have already been utilized or set aside for aesthetic reasons. It is unlikely that hydroelectric power, with the exception of pump storage, can make much of an additional contribution to domestic electricity generation. Pump storage, which is a method for storing less expensive base load power from off-peak hours for meeting peak demand, could substitute for some natural gas-fired turbines used for peaking power. Environmental impacts from pump storage facilities tend to be localized and to consist of destruction of wildlife habitat and, in open systems, disruption of stream flows.

Geothermal

Geothermal electricity generation is limited by the availability of geothermal resources and inadequate technology. Geothermal generating stations create negative air pollution, water pollution, noise, and aesthetic consequences.

Wind

The amount of electricity generated by wind power has expanded greatly over the last decade, driven in part by significant technological improvements. During 1998 and 1999, 925 megawatts of wind-powered generating capacity were added in the United States, mostly on Iowa and Minnesota farmland.

The main problem with wind-powered electricity generation is wind availability. Most wind systems only operate 25 percent of the time at 50-percent or less of capacity. The lack of wind constancy causes system stress and difficult voltage regulation. Early problems with noise and interference with television, radio, and other media transmissions have largely been solved through better designs and nonmetallic wind vanes.

However, wind-powered generating equipment must be carefully sited. Construction of the pads and access roads for wind farms located in arid, mountainous country can disturb large areas of sensitive land. The result is greatly increased soil erosion compared with what it would be from more traditional land uses, leading to siltation in nearby streams. The Altamont Pass wind resource area in California has been associated with high levels of bird mortality. Thus, wind energy development sites must consider the locations of major migration routes and areas that might funnel birds into the machines. The most modern wind generators are very large and revolve relatively slowly. These slower generators may partially alleviate the impacts to birds that have been noted with older models.

Visual aesthetics must also be considered in wind energy siting decisions. The crests of ridges and the sides of canyons are often the highlights of scenic areas. Generators in stark relief against the sky could create a devastating loss of aesthetic value to some observers. On the other hand, wind generation equipment may be aesthetically compatible with farmland in the Plain States that have some of the most reliable wind resources in the United States.

Solar

Solar generating technologies are expensive. However, photovoltaic cells are finding increased use to power facilities far from existing power lines. In recent years, the cost of photovoltaic cells has declined while their reliability has improved. Now, in many cases, it is cheaper to install photovoltaic cells than run a power line many miles over difficult terrain. The recent development of a successful photovoltaic film should significantly expand the range of applications for photovoltaic power.

Nevertheless, solar powered electricity will remain a high-cost alternative for the foreseeable future and will not make a major contribution to electricity generation because of its cost.

Solar powered electricity generation on a small scale has relatively minor environmental impacts. However, if solar power were ever to make a measurable contribution to national electricity generation, vast areas of land would have to be given over to this technology. Although the areas best suited to solar energy tend to be arid and thus fragile, many areas might be flat or on gentle slopes and not as susceptible to wholesale erosion as wind farms. Nevertheless, large-scale losses of vegetation and wildlife habitat, soil erosion, and resulting water pollution can be expected from large-scale solar generating facilities. Such facilities would also be aesthetically displeasing to some observers.

Other

Other potential sources of electric power such as tidal, ocean currents, and biomass lack the potential to make a serious contribution to the U.S. electricity supply. These alternatives are too expensive, lack feasible technology, or both. It is extremely unlikely that any exotic form of electricity generation makes even a 1-percent contribution to the U.S. electricity supply during the period of operation for this program.

4.7.3.2.2. More Efficient Generation and Transmission

Using more efficient generating equipment to produce the same amount of electricity as now could save an unknown, but large, amount of oil and natural gas. For instance, combined cycle systems are much more fuel efficient than straight turbines. The problem is that modern, efficient generating plants are very expensive. Power companies may have trouble justifying the expenditures to their stockholders on a financial basis. Furthermore, State regulatory agencies may be unwilling to allow additions to rates for plant construction while they allow standard rate adjustments for fuel costs. Saving oil and natural gas through more efficient generation would reduce the incidence and risk of all the environmental impacts associated with the oil and natural gas production saved, some of which would come from the OCS.

4.7.3.2.3. More Efficient Use and Less Use

More efficient use and less use of electricity by the industrial, commercial, and residential sectors could save the oil and natural gas (and other fuels) used to generate that electricity. These types of savings will be discussed under Section 4.7.3.3.

4.7.3.3. Industrial Sector Uses

4.7.3.3.1. Alternative Fuels

The trend in the industrial sector is to switch to natural gas or electricity produced from natural gas. It is unlikely that any significant savings of oil and natural gas will be made by the industrial sector switching to alternative fuels.

4.7.3.3.2. More Efficient Energy Use

Although the industrial sector as a whole spends a considerable amount of time and money developing methods for using energy more efficiently, there remain opportunities for saving vast quantities of energy in the industrial sector. Many consulting firms make it their business to help firms use energy more efficiently, but they tend to help only those firms with high enough levels of inefficiency to pay a portion of efficiency savings to a consultant. Many smaller opportunities for improvements go unaddressed. This is true for the use of natural gas, oil, electricity, and even other energy inputs such as coal.

One way firms in the industrial sector can improve their energy efficiency is by adopting state-of-the-art equipment. In many cases, new process or space heating and cooling equipment can save enough in energy costs to pay for itself in a reasonably short payback period. Choosing equipment that is the right size in terms of energy efficiency for the task at hand can reap related savings.

Another way firms can save energy is through improving the energy efficiency of their industrial processes. Although most "reengineering" activities in industry are aimed at using labor more efficiently, the same kind of thought can be used to save on the use of energy. Combinations of new processes with new, properly sized equipment can lead to especially significant energy savings.

Although some negative environmental impacts may be associated with the production of materials or equipment implemented in the process of achieving greater energy efficiency, these impacts tend to be negligible. Thus, improvements in the efficiency with which the industrial sector uses energy are almost entirely beneficial to the environment.

4.7.3.4. Residential and Commercial Sector Uses

4.7.3.4.1. Alternative Fuels

Just as in the industrial sector, the trend in the residential and commercial sectors is to switch to natural gas, when it is available, or electricity produced from natural gas. It is unlikely that any significant savings of oil and natural gas will be made by the residential and commercial sectors switching to alternative fuels.

4.7.3.4.2. More Efficient Energy Use

Once again, the residential and commercial sectors can use correctly sized state-of-the-art equipment to increase their efficiency of energy use. However, in terms of more efficient use, these sectors have some specific steps open to them that have broad application across the sectors. Potentially most important is the use of better designs and materials. Better designs take advantage of passive solar energy, minimize the openings to the outside, and take into account airflow as well as temperature to maximize comfort. Better materials include multipaned glass and insulating sheathing.

Insulation and weatherization can be especially effective in the residential sector. Programs to subsidize insulation and weatherization sponsored by electric utilities have cost-effectively spared utilities from having to install expensive new generating plants. In more sophisticated applications, zoning and time-of-day controls can be used to hold down unnecessary energy use in large residences and commercial establishments. More efficient appliances and appliance use can also add to the efficiency of the residential sector.

As was true in the industrial sector, any negative environmental impacts from increased production of more energy efficient heating and cooling equipment and appliances would be only marginal. Therefore, almost all the improvements in energy efficiency in the residential and commercial sectors would have positive impacts on the natural environment.

4.7.3.4.3. Less Energy Use

In the industrial sector, any decrease in energy use not associated with increased energy efficiency would lead directly to a decrease in production. In the residential sector, less energy use might lead to lower utility; however, the tradeoff might be a reasonable one. For instance, less heating and cooling might lead people to change their dress habits without causing much inconvenience. Everyday decisions like this could lead to positive impacts on the environment.

4.7.4. A Note on "Conservation"

The three types of conservation, improving the energy efficiency of production, increasing the efficiency of transport, and using less, all have two characteristics in common:

- There may be some negative environmental impacts associated with any new equipment required to achieve the efficiency, but these impacts will tend to be marginal.
- The net effect of these measures will generally be positive from an environmental point of view.

In addition, most energy conservation measures tend to substitute capital and labor for some sort of fuel. This substitution tends to create somewhat more employment, although, in general, the increase in employment is marginal and any regional impacts would be immeasurable. Furthermore, there is ample opportunity in our society to provide cost-effective subsidies to entice people to implement various conservation measures. Unfortunately the opportunities are not unlimited. Enticement to conserve will have to be constant, and each additional unit of conservation after an initial period of success will become incrementally more expensive. In other words, conservation has an upward sloping supply curve just as most other goods and services do. Thus, our society could decide to save energy and save money in the process, but only for a while. Eventually, saving more energy would become too expensive to continue. Conservation, then, can be an important part of a rational future energy plan, but it can only be one of several alternatives adopted to meet future energy demands.

4.7.5. Conclusion

In the short run, oil and natural gas are essential elements in the U.S. energy equation. Within the next few years, even vigorous government action can only shift the mix of energy alternatives to a minimal degree. Any major change in the energy mix will also require changes in behavior by individuals and institutions not under direct control of the government in the U.S. system. In an intermediate time period, other energy options like wind-powered electricity generation and hybrid-electric cars can begin to make inroads on hydrocarbon use if government gives these alternatives a sufficient boost.

Alternatives likely to help minimize environmental impacts in the long run are topped by conservation, the least polluting, most cost-effective option up to a point. However, conservation benefits are limited, as noted above. Other comers include hybrid cars and fuel cells in the ground transportation sector. New generation nuclear backed up with wind may power baseload electricity. Finally, hydrogen for urban industrial, commercial, and residential heating and related uses rounds out the list of potential minimum polluters likely to populate the energy economy. Oil and natural gas will be needed in the interim to power an economy that can generate the capital needed to implement these less polluting alternatives. The most likely and largest available alternatives to OCS production are imported oil and LNG. The environmental impacts associated with these alternatives represent important considerations when weighing the no action alternative.

4.8. Cumulative Case

The cumulative analysis considers impacts to the environment when the proposed action is added to past, present, and reasonably foreseeable future activities.

4.8.1. Scenario

To provide a framework for the cumulative impact analysis, the past, present, and future activities and proposals have been divided into two categories: Outer Continental Shelf (OCS) oil and gas activities and non-OCS oil and gas activities. The OCS activities are those activities that are associated with existing or proposed exploration and development of existing leases; exploration and development assumptions concerning the areas under consideration for lease; and in some planning areas, potential leasing activity as the result of subsequent OCS programs. Non-OCS activities are those activities that are not associated with the Federal OCS oil and natural gas program (e.g., commercial fishing).

4.8.l.1. OCS Oil and Gas Activities

Assumptions for OCS activities in the cumulative case take into account the regulatory requirements for identifying actions to be considered in the analysis, as well as the President's decision in June 1998 to withdraw from leasing until July 2012 eight planning areas and a portion of the Eastern Gulf of Mexico Planning Area, and to permanently withdraw currently designated national marine sanctuaries. The cumulative case assumptions were also based on whether a planning area is producing OCS oil and gas, is a frontier area (area without current production), or currently has some level of exploratory activity.

Cumulative production estimates for each region include production from the following categories of resources: (1) leased reserves, (2) leased resources, (3) resources expected to be leased as a result of sales in the new proposed program, and (4) resources expected to be leased as a result of subsequent OCS programs according to the assumptions below.

Gulf of Mexico Region

- The central and western portions of the Gulf of Mexico have one of the highest concentrations of oil and gas activities in the world. This level of activity is accompanied by extensive development of onshore service and support facilities. The onshore infrastructure is highly concentrated in the coastal areas of Louisiana and eastern Texas, and to a lesser extent, along the south Texas coast and east of Louisiana to Mobile, Alabama (Figure 3-16. Onshore Infrastructure Locations - Gulf of Mexico Region). Major onshore infrastructure includes gas processing plants, navigation channels, oil refineries, pipelines and pipeline landfalls, pipe coating and storage yards, platform fabrication yards, separation facilities, service bases, and terminals.
- It is expected that the vast majority of the onshore service, support, and hydrocarbon processing facilities already in existence will be sufficient to explore, develop, and produce oil and gas resources projected to result from prior, proposed, and future sales. It is assumed, for analysis purposes, that there will be about a 90-percent use of these facilities in support of future OCS operations.
- In the Central and Western Gulf of Mexico Planning Areas, we assume exploration, development, and production will occur on active leases, from remaining sales in the 1997-2002 OCS Program, from sales in the proposed program, and as a result of additional leasing subsequent to the proposed program.

- In the Eastern Gulf of Mexico Planning Area, we assume exploration, development, and production will occur from a few active leases north of latitude 26° N.; from sales in the proposed program; and from leasing in subsequent programs. We assume the area considered for leasing will correspond to the area in Sale 181.

Alaska Region

- The joint State of Alaska/Federal Northstar project in the Beaufort Sea has been approved and completed. Production of oil started in November 2001.
- The lifting of the export ban on Alaskan crude oil has led to some shipments to East Asia. Our understanding is that these shipments are infrequent and generally of limited quantities responding to transitory spot market opportunities. The vast majority of oil transported via the Trans-Alaska Pipeline System (TAPS) is still being sent to the U.S. west coast.
- In the Beaufort Sea Planning Area we assume development and production of oil will occur at the Northstar project. We also assume exploration, development, and production will occur on a few active leases, from sales in the proposed program, and from leasing subsequent to the proposed program.
- In the Cook Inlet Planning Area, we assume development and production of oil will occur from sales in the proposed program and as a result of leasing subsequent to the proposed program.
- In the Norton Basin Planning Area, we assume development and production of natural gas will occur as a result of a sale in the proposed program. The gas will be transported to shore by pipeline for delivery to industrial and consumer markets centered in Nome.
- In the Chukchi Sea Planning Area, we assume development and production of oil will occur as a result of combined Chukchi Sea/Hope Basin sales in the proposed program. Associated gas will be reinjected for reservoir pressure maintenance. The oil will be transported through a new overland pipeline to TAPS.
- In the Hope Basin Planning Area, we assume development and production of natural gas will occur as a result of combined Chukchi Sea/Hope Basin sales in the proposed program. The gas will be transported to shore by pipeline for local consumption.

Pacific Region

- There are 23 oil and gas production facilities in Federal waters off the coast of California. As of June 30, 1997, these facilities have produced a total of 842 million barrels (MMbbl) of oil and 908 billion cubic feet of gas. Currently, seven companies are operating offshore oil and gas facilities in the Pacific Region.
- Development and production of oil and gas may occur from the 36 currently undeveloped leases in the Southern California Planning Area. Hydrocarbons from eight of those leases could be produced from existing platforms. Resources from the other 28 leases would be produced from new platforms. The oil and gas would be transported to shore by subsea pipelines.

4.8.l.l.1. Exploration, Development, and Production Assumptions

To provide a basis for the analysis of future OCS exploration and development activities, hypothetical scenarios were developed using a range for exploration and development assumptions (Tables 4.6a and b. Cumulative Case—Exploration and Development Scenario). The basic assumptions concerning how oil and gas will be transported to shore, including whether tanker or pipeline will be used, are identical to the proposal (see Section 4.3.1.4.).

4.8.1.1.2. Oil -Spill Assumptions

The information and method used to derive the oil-spill assumptions for the proposed action (Section 4.3.1.5) were also used to derive the oil-spill assumptions for the cumulative case. Table 4-6c. (Cumulative Case—Oil-Spill Assumptions) presents the number of large oil spills assumed to occur as a result of OCS oil production and transportation, tanker transportation of Alaska North Slope crude oil, and import tankers. The source and number of assumed OCS spills were based on the volume of anticipated oil production, the assumed mode of transportation (pipeline and/or tanker), and the spill rates for large spills. Assumptions regarding the number of large oil spills from import tankers were based on the estimated level of crude oil imports (Section 4.7.2.1.1.) and worldwide tanker spill rates. It is also assumed that these spills would occur with uniform frequency over the life of the proposed action.

4.8.1.2. Non-OCS Activities

4.8.1.2.1. Dredging and Marine Disposal

Dredging operations are routinely conducted for channel construction and maintenance, pipeline emplacement, access to support facilities, creation of harbor and docking areas, and siting for onshore facilities. Offshore disposal, authorized under Title I of the Marine Protection, Research and Sanctuaries Act of 1972, as amended (33 U.S.C. §1401), and the Federal Water Pollution Control Act, as amended (33 U.S.C. §1251), consists primarily of dredge spoils.

Gulf of Mexico Region.

There are currently 35 operational ocean disposal sites in the Gulf of Mexico (as of January 2001), including dredge material disposal sites, most of which are located in State waters. Of these 35 operational sites, 16 are located in the western Gulf of Mexico (12 final, 3 interim, and a single undesignated site), 9 are in the central Gulf (5 final and 4 interim sites), and 10 are in the eastern Gulf (5 final, 3 interim, and 2 undesignated sites). These sites are primarily used for the disposal of dredged material from channel dredging programs (U.S. Environmental Protection Agency [USEPA], 2001). In 1999, over 25 million cubic meters (m^3) of dredge material were disposed of at Gulf of Mexico ocean disposal sites (U.S. Army Corps of Engineers [COE], 2001).

Alaska Region

Two ocean disposal sites are currently operational in the Alaska Region, both of which occur offshore of Nome. These sites, both of which have been designated as final disposal sites, have realized only limited use.

Pacific Region

There are 31 ocean disposal sites in the Pacific Region, including 20 off the Washington-Oregon coast (12 final, 5 interim, and 3 undesignated sites) and 11 off California (4 final, 4 interim, and 3 undesignated). Disposal activity varies significantly by site, being closely tied to harbor dredging and maintenance activities at adjacent ports. Total volume of dredge disposal along the U.S. west coast in 1999 was approximately 9.1 million m^3 (COE, 2001).

4.8.1.2.2. Coastal and Community Development

Coastal and upland development may affect the natural flow of rivers and streams, or may introduce new or additional loads (e.g., sediments, organics) to riverine systems.

Gulf of Mexico Region

Mississippi River Flood Control: Alterations in the hydrology of the Mississippi River basin have caused declines in sedimentation rates and have contributed to marsh deterioration in the coastal wetlands of Louisiana in recent decades. Flood control levees on the lower Mississippi River and its tributaries have contributed to wetlands loss in the Gulf via elimination of overbank flooding, preventing distribution of alluvial sediments across the Mississippi River Delta.

Submergence of Wetlands: Submergence is estimated to account for coastal wetland losses of 13,000 hectares per year in coastal Louisiana, the highest among Gulf States. Subsidence rates vary depending upon local geologic conditions. Primary natural processes responsible for land subsidence include geosynclinal downwarping, compaction, dewatering, and the horizontal flow of recent sediments. Anthropogenic factors, such as fluid withdrawals from oil and gas reservoirs, appear to have only a localized influence on subsidence directly above the reservoirs. Submergence of wetlands is also considered a factor in erosion of wetlands in the western portion of the Gulf of Mexico. In addition, submergence along the Texas coast has been compounded in some areas by human-induced land subsidence from groundwater withdrawals and natural compactional subsidence.

Regional Habitat Loss via Natural Processes: Several major natural processes create problems in the coastal zone, including (1) hurricanes (i.e., breaching of barrier islands and dunes via high and intense flood surges, flooding of low-lying coastal areas); (2) storm and normal conditions (i.e., accelerating shoreline erosion); (3) inland flooding along floodplains; and (4) surface faulting and land subsidence.

Alaska Region

Alaskan Anadromous Habitat Loss: Logging activity (e.g., in southeastern Alaska, within the Tongass National Forest and elsewhere) can affect salmon streams and nearshore marine habitat via: (1) siltation (i.e., reduces gravel permeability in streams with consequent loss of salmon eggs and pre-emergent fry); (2) stream blockage (i.e., resulting from buffer strip blow downs following cutting); and (3) water warming (i.e., from loss of shade after cutting, with possible adverse effect on adult spawners and rearing fry).

The North Slope Borough Capital Improvements Program: This large program has been used to (1) construct schools and houses, (2) acquire gravel and land, (3) improve airport runways, (4) improve power generation and water and sewer systems, (5) acquire maintenance equipment and search-and-rescue helicopters, and (6) initiate areawide communications and solid-waste-disposal improvements for villages of the North Slope. While many of the projects have been completed, the focus of future expenditures emphasizes health and human services, safety, and the maintenance of facilities already built.

Pacific Region

Coastal development in the Pacific Region is limited. Along the coasts of Washington and Oregon, no major development efforts were identified. In California, major coastal activities include continuing harbor maintenance (Section 4.8.1.2.1) and harbor expansion projects (Los Angeles-Long Beach 2020 Project, Oakland Harbor).

4.8.1.2.3. Municipal Wastes and Other Effluent

Major point sources of discharged waste materials into nearshore and coastal waters are sewage treatment facilities, industrial facilities, and electric generating facilities. Non-point source pollution has also come under increasing scrutiny. Effluent from industrial and sewage treatment facilities may contain substantial quantities of synthetic organics, heavy metals, suspended solids, oxygen-consuming materials, and nutrients. Sewage effluent may also contain fecal coliform and potentially pathogenic microorganisms. Power plant cooling waste discharges may be elevated in temperature and have increased chlorine levels. Contaminants may also enter marine and coastal waters from marine transportation (e.g., routine operational discharges, accidental spills), including commercial tanker and ship traffic and recreational vessels.

Gulf of Mexico Region

Sewage treatment, industrial, and electrical generating facility outfalls occur throughout the Gulf region. Commercial vessel operations are also prevalent, with 15 Gulf Coast ports handling between 10 million and 275 million tons of cargo annually. As of 1999, total tanker traffic in the Gulf included an estimated 15,220 foreign and 1,114 domestic tanker vessel transits into port per year (see Sections 4.8.1.2.7 and 4.8.1.2.8).

Alaska Region

Dumping of oily bilge water and toxic chemicals by cruise ships into southeast Alaska coastal waters has been recognized as a substantial problem. The Alaska Department of Environmental Conservation is urging the cruise industry to voluntarily control this pollution.

Pacific Region

Sewage treatment facilities occur throughout the coastal region of the Pacific coast, with the largest facilities operating within major metropolitan areas and smaller operations servicing smaller coastal communities. In the Seattle-Tacoma metropolitan area, treated municipal sewage discharges are released into Puget Sound, while treated sewage from Portland is discharged into the Columbia River. Discharges from the four major outfalls in southern California into the Southern California Bight (i.e., City of Los Angeles, County of Los Angeles, Orange County, City of San Diego) amounted to 1,106 million gallons per day in 1996.

4.8.1.2.4. Nonenergy Minerals

Gulf of Mexico Region

The sulphur industry along the Louisiana and Texas Gulf Coast has been active since the 1920's, where sulphur from the cap rock of coastal and offshore salt domes is mined. Two offshore mines, operated by Freeport-McMoran, are in existence off Jefferson Parish, Louisiana. In support of the offshore mines, Freeport-McMoran operates a shore support base located on the eastern end of Grand Isle, Louisiana. Production from the Grand Isle Mine is transported by pipeline to the Grand Isle facility where it is transferred to insulated barges for transportation to the shipping and processing terminal at Port Sulphur, Louisiana. Much of Freeport's sulphur is shipped up the Mississippi River to processing facilities in Louisiana or to Tampa, Florida, for use in the fertilizer industry. At present, there is one producing sulphur lease in Federal waters in the Gulf of Mexico. Freeport-McMoran operates the Main Pass Mine, located in Main Pass Block 299, near the Mississippi River Delta. Sulphur production platforms are similar in nature to oil production platforms. Since the withdrawal of sulphur ore takes place from rather shallow deposits above salt domes, subsidence of the seafloor in the vicinity of the platforms can occur, affecting nearby oil production facilities and pipelines.

Alaska Region

The Red Dog Mine, the largest lead and zinc mine in the world and the only base-metal lode mine currently in production in northwest Alaska, is located 87 kilometers (km) from the Chukchi seacoast (145 km north of Kotzebue). The seaport for the mine is located approximately 27 km southeast of Kivalina. Full production began in 1993. The port facility for the mine consists of a dock and causeway 40 m wide and 60 m long that extends into a water depth of 4 meters (m). Ore is shipped during open-water periods to smelters on the Pacific Coast of North America, the Far East, and Europe. The life of the field is estimated at 50 years.

4.8.1.2.5. State Oil and Gas Development

Gulf of Mexico Region

Oil and gas exploration and development activities in State or territorial waters of the Gulf of Mexico are variable. For example, off Texas in 1999, 11 rigs were drilling for oil or gas in State offshore waters, and two were located in inland waters. During the same period, 98 rigs were operating in Louisiana State offshore waters, and 18 were located in inland waters. Both Louisiana and Texas have experienced considerable oil and gas development within their coastal areas including exploratory drilling, production platform installation, pipeline installation, and canal construction. Such operations may be expected to continue into the foreseeable future. In contrast, the State of Mississippi has experienced a limited amount of nearshore oil and gas activity; three exploratory wells were drilled in the 1950's, all of which were dry holes. Oil and gas activity in offshore waters of the State of Alabama has increased in recent years. The Lower Mobile Bay Mary Ann Field was discovered in 1979. Since that initial discovery, several others have been made, confirming the commercial potential of natural gas in Mobile Bay. There are two producing fields in Alabama State waters: the Lower Mobile Bay May Ann Field and the South East Mobile Bay Field. The State of Florida has experienced a limited amount of drilling in State coastal waters. Between 1945 and 1983, 29 exploratory wells were drilled in waters under Florida jurisdiction at sites extending along the entire Gulf coast from Pensacola to the Keys and Dry Tortugas. None of these wells resulted in development or production. Currently, there is a moratorium on drilling activity in Florida state waters. The State has no plans for lease sales in the future, and no rigs are operating within the State.

Alaska Region

The State of Alaska has more than a million offshore acres currently under lease, with the majority of the leases on the North Slope and nearshore waters of the Beaufort Sea, as well as within Cook Inlet. Exploratory drilling on the North Slope during the mid to late 1990’s has resulted in numerous discoveries (e.g., Alpine Field in the Colville River delta, Cascade, Tarn, Fiord, Midnight

Sun/Sambuca, Nanuk, Eider, Pete's Wicked, and Tabasco). The Beaufort Sea and Cook Inlet are the only areas in Alaska with producing offshore leases, and all facilities are located in State waters. About 98 percent of the State of Alaska's oil production comes from North Slope fields, and over the next decade the bulk of Alaskan oil production is expected to continue from currently producing fields on the North Slope, including Prudhoe Bay, Kuparuk, Point McIntyre, Endicott, Milne Point, Lisburne, and a number of smaller satellite fields (Alaska Department of Natural Resources [ADNR], 2000). Projections by the State of Alaska (ADNR, 2000) show that production from existing fields will decline from a rate of 1.027 MMbbl/day in 2000 to 0.394 MMbbl/day in 2021. Oil produced from the North Slope and Beaufort Sea is transported down the TAPS pipeline to Valdez, Alaska, where it is loaded on tankers and exported. Significant volumes of natural gas (over 35 trillion cubic feet) have been produced along with oil recovery in North Slope fields; however, a relatively small amount (3.7 trillion cubic feet) has been utilized as fuel for facilities, and the remainder has been reinjected to enhance oil recovery.

All natural gas produced for outside markets comes from fields in the upper Cook Inlet, both onshore and offshore. The majority of gas production from Cook Inlet is converted to other forms and exported, both as liquefied natural gas (LNG) (to Japan) and urea-fertilizer (various worldwide locations). The Cook Inlet LNG facility is the only LNG export operation in the United States. The Cook Inlet region produces both oil and natural gas, although many of the fields have been producing for decades and are over 90 percent depleted. Peak oil production was in 1970 at 0.226 MMbbl/day and has declined to a present rate of about 0.010 MMbbl/day. From 1970 to the present, annual gas production has ranged between 218.3 and 311.5 billion cubic feet per year. Because all the known oil and gas fields are nearing the end of their life, the State of Alaska estimates future production only to the year 2004 (ADNR, 2000). At current rates of oil and gas production and consumption, a shortage will likely occur within the next decade or so if additional fields are not discovered and brought into production. If new oil and gas discoveries were made in State or Federal OCS areas of the Cook Inlet region, future oil production would be marketed and consumed locally. A portion of future gas production could continue to be exported under existing LNG and fertilizer contracts to outside markets.

Pacific Region

Currently, there are no oil or gas extraction activities occurring in Washington or Oregon State waters. In State waters offshore California, oil and gas production (as of mid-1999) was occurring from 18 leases (i.e., 10 producing leases offshore Orange County, one offshore Los Angeles County, five offshore Ventura County, and two offshore Santa Barbara County).

4.8.1.2.6. Canadian Oil and Gas Activity

Drilling began in northern Canada in the 1960's, with over 237 wells drilled in the Canadian arctic, both offshore and onshore. Most of the large oil discoveries have been offshore, while the largest gas discoveries are onshore. Exploration wells have been drilled from gravel islands, caisson-retained islands, bottom-founded mobile units (Semisubmersible drilling caisson and mobile arctic caisson), and floating units (drillships and a conical drilling unit). Tuktoyaktuk and McKinley Bay are the primary service bases; additional facilities are on Hershel Island and have been proposed for King Point in the Yukon Territory. McKinley Bay's ship-repair facilities are adequate to service the entire range of vessels present in the arctic. In spite of promising discoveries, no oil or gas development has occurred. Various studies have been conducted to transport natural gas down a gas pipeline constructed through the Mackenzie River Valley. One variation includes a spur pipeline connecting stranded gas on the North Slope of Alaska to this new Canadian gas pipeline. Options studied for oil transportation systems include tanker routes through the Northwest Passage, tanker routes westward along Alaska and through the Bering Sea to Asia, an overland pipeline through the Mackenzie Valley, and a combined tanker-pipeline route. All studies have concluded that the current prices for oil and gas do not warrant commercial development.

4.8.1.2.7. Domestic Transportation of Oil and Gas

Gulf of Mexico Region

The Deepwater Port Act of 1974 (33 U.S.C. § 1501) gives the U.S. Department of Transportation (USDOT) the authority to license deepwater ports. The purpose of a deepwater port is to provide offshore terminal facilities for the offloading of oil from tankers too large (typically supertankers with drafts greater than 40 feet and up to 700,000 deadweight tons) for conventional ports and to transport the oil to shore via pipeline, thus avoiding the need for lightering. The Louisiana Offshore Oil Port (LOOP) is the only deepwater port in the Gulf. It is located in Grand Isle Block 59, approximately 19 miles from shore. Vessel access to the LOOP is by means of the designated fairway and safety zone, within which no mobile drilling operations or installation of permanent structures may take place. An anchorage area is also designated in the vicinity of the LOOP. Fixed and mobile structures may be placed in anchorages under certain spacing limitations.

Vessels operating offshore in the Gulf of Mexico often use the network of established safety fairways. Over the years, an extensive shipping pattern developed among the major ports and between the ports and final destinations. As with all marine transportation, storms, operational errors, and mechanical failures can all result in groundings or in collisions involving other vessels or fixed structures such as platforms and rigs. This may lead to losses in lives and property, and possibly environmental damage if hazardous cargo were involved. Because of the large number of platforms in the Gulf of Mexico at any particular time and the number of exploratory drilling rigs that may be operating, an important mitigation factor for this problem was the establishment of a series of safety fairways and anchorages to provide an unobstructed approach for vessels using U.S. ports. Fairways play an important role in the avoidance of collisions on the OCS, particularly in the case of the larger ocean-going vessels, but not all vessels stay within the fairways. Many vessels, such as fishing boats and vessels supporting offshore oil and gas operations, travel through areas with high concentrations of fixed structures. In such cases, the most important mitigation factor is the requirement for adequate marking and lighting of structures. After a structure has been in place for a while, it often becomes a landmark and a navigational aid for vessels that operate in the area on a regular basis.

There is a substantial amount of domestic waterborne commerce along the Gulf Coast that does not always use open Gulf waters. Vessels engaged in this activity generally use the Gulf Intracoastal Waterway, which follows the coastline inshore and through bays and estuaries and, in some cases, offshore from Fort Myers, Florida to Brownsville, Texas.

Alaska Region

Trans-Alaskan Pipeline System: The TAPS began transporting crude oil from Prudhoe Bay on the Alaska North Slope to Valdez in 1977. The system includes a 48-inch diameter oil pipeline, pump stations, tank farm and marine loading terminal in Valdez, and a fleet of oil tankers. Peak pipeline throughput was slightly over 2.0 MMbbl/day in 1988, with current leve1s at approximately 1.1 MMbbl/day. The Valdez terminal handles up to four tankers at a time, ranging in size from 90,000 to 262,000 deadweight tons (635,000 to 1.8 MMbbl capacity). From 1977 to 2000, the Valdez terminal facility handled more than 13.0 billion barrels (Bbbl) of oil. Most Alaskan crude travels from the

Valdez terminal to west coast ports (largely Puget Sound, San Francisco Bay, and Los Angeles-Long Beach area). A small, declining percentage goes to Gulf of Mexico ports.

In late November 1995, President Clinton signed legislation [30 U.S.C. 185(s)] that authorized exporting crude oil from Alaska's North Slope in U.S. flag carriers. The routing of tankers carrying oil to the Far East is from the Valdez TAPS terminal, heading west and then south of the Aleutian Islands. This routing brings tankers more than 200 miles offshore the Aleutian Islands. It is estimated that this export averages about 50,000 to 60,000 barrels (bbl) daily, or about 6 percent of the North Slope production.

Domestic Petroleum Product Imports: The USDOT statistics indicate that, in 1999, Alaska ports received 1 million metric tons of refined petroleum products.

Pacific Region

As noted above, most Alaskan crude travels from the Valdez terminal to U.S. west coast ports in Puget Sound, San Francisco Bay, and the Los Angeles-Long Beach area. For Pacific Region ports, refined petroleum products dominate the trade, with 39 million metric tons received in 1999 (25 million metric tons via domestic tankers and tank barges; 14 million metric tons via imports). Crude oil trade into Pacific Region ports accounted for 5 million metric tons, all by tanker, with 80 percent of crude oil being received at California ports and 20 percent offloaded in the Pacific Northwest (USDOT, 2001).

4.8.1.2.8. Foreign Crude Oil Imports

Gulf of Mexico Region

Tanker traffic in Gulf of Mexico ports was set at 32,668 total transits (inbound plus outbound) in 1998. This comprised 15,222 foreign tanker visits (inbound) and 1,114 domestic tanker visits (inbound), with outbound traffic equaling inbound activity (USDOI, MMS, 2000d).

Alaska Region

In 1999, USDOT statistics accounted for no imported crude oil activity in Alaska ports. Only domestic petroleum products were received by Alaska ports (USDOT, 2001).

Pacific Region

In 1999, waterborne petroleum product shipments to West Coast States totaled about 41 million metric tons. Imports accounted for 34 percent (nearly 14 million metric tons) of these shipments, of which 12 million metric tons arrived at California ports and 2 million metric tons arrived at Pacific Northwest ports (USDOT, 2001).

4.8.1.2.9. NASA and Department of Defense Activities

Gulf of Mexico Region

U.S. Navy assets that might be operational on a transitory basis within the Gulf include surface vessels, submarines, and aircraft, typically operating between a shore base and offshore waters. Navy bases along the Gulf Coast are found at Pascagoula (Mississippi), Pensacola (Florida), Corpus Christi and Ingleside (Texas), and New Orleans (Louisiana). The U.S. Coast Guard (USCG) conducts routine activities and search-and-rescue operations using both surface vessels and aircraft. The USCG air station facilities in the Gulf Region are found at Houston and Corpus Christi (Texas) and New Orleans (Louisiana), while stations are also maintained at Port Aransas, Port O'Connor, Padre Island, Galveston, and Sabine Pass (Texas); Grand Isle, Venice, and New Orleans (Louisiana); Gulfport and Pascagoula (Mississippi); Mobile (Alabama); and Pensacola, Destin, and Panama City (Florida). Similarly, the U.S. Air Force may conduct aerial operations over the deepwater region of the Gulf; U.S. Air Force facilities in the Gulf include Tyndall Air Force Base in Panama City, Florida.

Alaska Region

The U.S. Air Force, U.S. Navy, and USCG conduct flight and vessel operations in the Anchorage (Cook Inlet) area and in the Aleutians.

Pacific Region

Naval facilities in the Pacific Region are found at Whidbey Island, Bremerton/Bangor, and Everett (Washington) and San Francisco, Lemoore, and San Diego (California). Vessel activity includes entrance into and exit from sounds and bays to reach the open ocean.

4.8.1.2.10. Other Projects and Proposals

Alaska Region

Alaska Natural Gas Transportation System: This proposal would link the stranded gas resources in the U.S. and Canadian arctic. One route being considered would have a new gas pipeline running parallel to TAPS from the North Slope to Fairbanks and then east through the Yukon Territory connecting to the gas transmission system in northern Alberta, Canada. Another alternative, the “over the top” route, would follow the floor of the Beaufort Sea eastward to Canadian waters, then head south through the MacKenzie River Valley to northern Alberta. Some permits and feasibility studies have been conducted. However, the delivery price has been estimated to be $2.82 to $4.17 per thousand cubic feet. The commercial viability of these projects is unknown.

Gas-to-Liquids Conversion of Stranded Natural Gas Resources: Renewed research and development into an innovative technology to convert natural gas to a refined liquid product is underway among numerous industry and government groups. Pilot projects are planned at several worldwide sites, including the North Slope. The concept is that natural gas, stranded in remote areas for the lack of a viable transportation system, could be converted into liquid form and transported through existing oil pipelines. This new technology could eventually lead to commercial development of huge gas resources on the North Slope. A 1999 U.S. Department of Energy study concluded that a phased-in gas-to-liquid transportation plan was more economically viable than a full-scale LNG project to exploit North Slope gas. The gas-to-liquid transportation option was not included in the cumulative case because feasibility studies and a pilot project have not been concluded. It is unlikely that such a project would be initiated before 2010.

Arctic National Wildlife Refuge (ANWR): The ANWR is located in northeast Alaska flanked by State lands west of the Canning River, with the Beaufort Sea on the north and the Canadian border on the east. Only a small portion of the northern coastal plain of ANWR has high oil and gas potential. This prompted Congress to add Section 1002 to the Alaska National Interest Lands Conservation Act

(ANILCA), which set-aside this so-called "1002 area" for further study and prescribed guidelines for the Secretary of the Interior to follow in developing recommendations for use of the coastal plain. The remainder of ANWR was set aside as a wilderness area. In 1987, the Secretary of the Interior recommended to Congress that the entire ANWR coastal plan be made available for oil and gas leasing. The resource potential of the 1002 area is estimated to be between 4.72 Bbbl ($18/bbl) and 6.3 Bbbl ($30/bbl) of economically recoverable oil (USDOI, U.S. Geological Survey, 1999). Leasing in the ANWR 1002 area is stalled because Section 1002 of the ANILCA prohibits oil and gas leasing and development in ANWR until authorized by an Act of Congress. It is uncertain whether Congress will enact and the President will approve legislation to authorize leasing of the ANWR coastal plain in the foreseeable future. For analysis purposes, it has been assumed that no development will occur during the 2002-2007 time period.

National Petroleum Reserve-Alaska (NPR-A): The NPR-A lies in northwestern Alaska bordered on the east by State lands, on the north by the Beaufort Sea, and on the west by the Chukchi Sea. Following nearly 15 years of dormancy, renewed interest in NPR-A was sparked by the Alpine discovery (1994) adjacent to the northeast portion of this Bureau of Land Management-managed area. Upon completion of a new integrated activity plan/environmental impact statement, the Secretary of the Interior signed a record of decision in 1998 approving oil and gas lease sales in this northeastern portion of NPR-A. A lease sale was held in May 1999, and 133 tracts were leased. The first applications for exploration wells permits were approved in 1999, and ARCO Alaska is planning to drill at least two wells during the winter season 1999-2000. The resource potential of NPR-A is estimated to be between 0.494 Bbbl ($18/bbl) and 2.163 Bbbl ($30/bbl). Although the level of future oil and gas development activity within the NPR-A is speculative at this time, some development and production are assumed as part of the cumulative analysis.

4.8.2. Gulf of Mexico

4.8.2.1. Water Quality

4.8.2.1.1. Marine

In addition to the proposed OCS action, some routine ongoing and future OCS activities (Table 4-6a) will have impacts on marine water quality. Examples include discharge of drilling fluids and cuttings and produced waters. Bottom area disturbances (also listed in Table 4-6a) including installation of new platforms and pipelines will resuspend bottom sediments and increase turbidity in the short term. Drilling related discharges will have a localized impact on the turbidity of marine waters in the near vicinity of drilling operations. Increases in water turbidity can cause the deaths of gilled organisms and filter feeders (Kelso, pers. commun.). In the presence of increased turbidity these organisms often secrete mucus to reduce the amount of particles taken in over the gills. As the turbidity increases so does the mucus production which will ultimately prevent the organism's access to oxygen.

Routine activities occurring under the non-OCS cumulative scenario that contribute to total cumulative effects on marine water quality include the transportation of oil and gas (domestic transport, foreign imports), and National Aeronautics and Space Administration (NASA), U.S. Department of Defense (USDOD), and USDOT activities. Dredging and marine disposal, municipal wastes, domestic and foreign tankers, military or USCG vessel discharges will have an impact on marine water quality. Non-OCS extraction activities of minerals, and oil and gas from State waters also impact marine water quality, but to a lesser extent since most of these activities occur in nearshore waters. Some of these activities such as the disposal of municipal wastes will not have much, if any, impact on the marine environment because they are located along the coast or inland. Coastal wetlands act as a filter and sink for many of these coastal discharges so they never reach offshore in any significant concentration.

It is estimated that about 29 large spills could occur in the Gulf of Mexico Planning Areas from OCS activities over a 60-year period. At the same time, as many as 47 large spills could occur in the Gulf of Mexico from import tankers (Table 4-6c). Many of these spills could occur some distance from shore and would affect marine water quality. These spills would temporarily reduce the affected water quality and would add associated contaminants into the water column.

Accident locations are unknown, given the possibility of accidental oil release from vessel collision (anywhere on the OCS or in State waters) or transfer/lightering operations at the Louisiana Offshore Oil Port (or in other ports).

Conclusions: The overall cumulative effects on marine water quality from OCS and non-OCS routine activities are **minor**. The overall impact from large spills from the Federal OCS, State waters, and import tankers on marine water quality is estimated to be **minor**. The extent of the impacts of the 2002 OCS Program on marine water quality is expected to be **minor**.

4.8.2.1.2. Coastal

The existing infrastructure for vessel traffic is sufficient for activities associated with the proposed action. Therefore, large-scale construction activities in coastal waters beyond those associated with the OCS cumulative scenario would not occur. Anticipated levels of vessel-associated discharges in coastal waters are included in the evaluation presented in Section 4.8.2.1.1. There would be some degradation of water quality in coastal areas associated with the OCS cumulative scenario, but implementation of the activities under the proposed action would not substantially degrade coastal water quality more than what is associated with the OCS cumulative scenario.

Other routine OCS activities (Table 4-6a) having cumulative impacts include the discharge of drilling fluids and cuttings and produced waters which will cause localized increases in turbidity. Bottom area disturbances, including installation of new platforms and pipelines, will resuspend bottom sediments and increase turbidity in the short term. Drilling-related discharges will also have a localized impact on the turbidity of coastal waters in the near vicinity of drilling operations.

Activities occurring under the non-OCS cumulative scenario that may contribute to total cumulative effects on coastal water quality include dredging and marine disposal, municipal wastes and other effluents, other extraction activities (nonenergy minerals, oil and gas from State waters), transportation of oil and gas (domestic transport, foreign imports), and NASA/USDOD/USDOT activities. Transportation of oil and gas and NASA/USDOD/USDOT activities occur in both nearshore and offshore waters. All of these activities would have an effect on coastal water quality.

Some of the 29 large OCS spills estimated in the cumulative case would occur in nearshore waters. Import tanker spills occur most frequently when the tankers are approaching port. Therefore the majority of the 47 import tanker spills estimated for the 60-year period in the cumulative case would occur in nearshore waters.

Spills in the coastal environment have an increased potential to negatively impact water quality. Shallow water and increased wave action increases the potential for entrainment of oil in the water column. If the oil were to reach mangroves and wetlands, it would be more difficult to remove and could continually reinoculate the surface water until the oil finally dissipated.

Conclusions: The overall cumulative impacts from routine OCS and non-OCS activities are **minor** to **moderate**. Overall impact from large spills in coastal waters could be **minor** to **moderate**. Contributing impacts from the 2002 OCS Program to cumulative impacts would be **negligible** to **minor**.

4.8.2.2. Air Quality

The cumulative analysis considers the impacts from all future OCS oil and gas development, OCS emission sources not related to oil and gas activities, and onshore emissions.

Onshore emission sources include power generation, industrial processing, manufacturing, refineries, commercial and home heating, and motor vehicles. Nationwide, nitrogen oxide (NO_x) emissions have remained fairly steady since the mid-1970s, while sulfur dioxide (SO_2), 10-micron particulate matter (PM_{10}), and volatile organic compound (VOC) emissions have declined significantly over the past several decades (USEPA, 2000b). A very slight decline in nationwide emissions is projected for the period of 2000 through 2010 (USEPA, 2000b). In the ozone nonattainment areas, which include the Houston area in southeast Texas and the Baton Rouge area in Louisiana, emissions of NO_x and VOC are being reduced through the State Implementation Plan (SIP) process in order for those areas to achieve compliance with the Federal ozone standard. In all areas, motor vehicle emissions are expected to decrease over time because of increasingly stringent emission standards on new vehicles. Also, the USEPA is promulgating emission standards for a variety of non-road engines and marine vessels. All these factors would tend to result in decreased onshore emissions in the future. While these reductions will be counteracted to some extent by industrial growth, population increase, and increases in motor vehicle travel, overall emissions should decrease, particularly in those areas where pollutant levels presently exceed the national ambient air quality standards (NAAQS).

On a regional basis, emissions on the OCS account for about 10 percent of the total NO_x emissions and about 2 percent of the total VOC emissions (USDOI, MMS, 1995a). These include emissions from sources not related to oil and gas, such as cargo vessels, oil tankers from foreign ports, commercial fishing boats, recreational fishing boats, military vessels, and recreational boating. Oil- and gas-related activities account for about 60 percent of the total NO_x emissions on the OCS and about 75 percent of the total VOC emissions (USDOI, MMS, 1995a).

Table 4-12 lists the yearly average emissions associated with all past, present, and future OCS oil and gas activities in the Gulf of Mexico. The tables show a range of emissions; the low and high emission values reflect the low and high resource estimates, respectively. Most of the emissions are associated with activities in the Central Planning Area, while the Eastern Planning Area has the lowest emission rates. The level of activity is expected to remain relatively level throughout the period considered in the cumulative analysis. The total number of production facilities would be relatively constant over time. As older platforms are removed after the resources are exhausted, new ones are installed in other areas with oil and gas resources. Emissions would, therefore, not change significantly over the period. For the low-case cumulative emissions scenario, the emissions are about the same as those calculated for the 1992 activities in the Gulf of Mexico OCS (USDOI, MMS, 1995a). For the high case, the emissions are about 40 percent greater. The emissions associated with the proposed 5-year program are about 10 percent of the total OCS oil and gas activities.

Impacts Associated with NO_2, SO_2, PM_{10}, and CO

All coastal areas adjacent to the Gulf of Mexico meet the NAAQS for nitrogen dioxide (NO_2), SO_2, PM_{10}, and carbon monoxide (CO). As overall future emissions are not expected to change significantly, future ambient concentrations would remain well within the NAAQS and the Prevention of Significant Deterioration (PSD) maximum allowable increases. The cumulative air quality impacts would be minor.

The air quality analysis presented in Section 4.3.2.2 showed that the contributions from existing OCS emissions in the Gulf of Mexico are well within the maximum allowable increases for PSD Class II areas. The projected emissions for all future OCS oil and gas activities in the Gulf are about the same as present-day OCS emissions. The contribution of pollutant concentrations from the cumulative OCS program would, therefore, be similar. Even with the higher emissions associated with the high-case cumulative scenario, the contributions would be within the maximum allowable limits. The projected emissions from the proposed 5-year OCS program would be only about 10 percent of the cumulative OCS emissions. The contributions from the proposed 5-year program would, therefore, be very small.

The Section 4.3.2.2 analysis also appears to indicate that pollutant concentrations in the Breton Class I area from existing emission sources are within the maximum allowable PSD increments. Future pollutant concentrations, therefore, should remain within the PSD limits. Nevertheless, there has been concern about the combined impact of offshore and onshore emission sources on the Class I increments in Breton. For this reason, the MMS is gathering information for generating emission inventories for OCS facilities located within 100 km of the Breton Class I area. The emissions data will be used by MMS in modeling to evaluate the contribution of OCS sources to pollutant concentrations in Breton. In addition, the MMS has initiated a consultation program with the FWS. Under this program, the USDOI, Fish and Wildlife Service (FWS) has an opportunity to review plans for activities within 100 km of Breton that exceed a certain emission threshold. Mitigation measures, such as the use of low-sulfur fuel, are applied to the larger emissions sources.

In summary, the concentrations of NO_2, SO_2, and PM_{10} would be within the applicable maximum allowable levels. The concentrations would also be well within the NAAQS. The cumulative impacts would be minor. The impacts from the proposed 5-year program on the pollutant levels would be minor.

Ozone

There are a number of areas in Texas and Louisiana that presently experience ozone concentrations that exceed the NAAQS. In seven counties around Houston, the nonattainment area is classified as severe. The Clean Air Act mandates that the area shall meet the Federal standard by the year 2005. The other areas are in the serious category, and were required to comply by the year 1999. However, these areas have still not achieved the standards. The implementation of the 8-hour ozone standards could result in more areas being classified nonattainment for ozone. This may include a number of parishes in Louisiana as well as counties in Mississippi, Alabama, and the Florida Panhandle. It is likely, therefore, that ozone problems will persist in the Gulf coastal areas for some years to come.

In areas that violate the Federal ozone standards, the air quality impacts would range from moderate to major. The impacts are major in some areas because ozone can cause irreversible damage to the health of some individuals who are most sensitive to it. Outside the ozone nonattainment areas, air quality impacts would be minor.

The impacts from OCS activities on ozone were evaluated in the Gulf of Mexico Air Quality Study [GMAQS] (USDOI, MMS, 1995a). This modeling focused on the southeast Texas and Baton Rouge, Louisiana, ozone nonattainment areas. It was determined that OCS sources contributed little to onshore ozone concentrations in either the southeast Texas or the Baton Rouge areas. At locations where the model predicted ozone levels exceeded the 1-hour standard of 0.12 parts per million (ppm), OCS emissions contributed less than 2 parts per billion (ppb) to the total concentrations. This is less than 2 percent of the ambient standard. These contributions were found in only a small geographic area during any particular episode. At locations where the model predicted ozone levels were much less than 0.12 ppm, the highest OCS contributions were around 6-8 ppb. When the modeling was performed with double the OCS emissions, the highest OCS contributions at locations where the predicted ozone levels exceeded the standard were 2-4 ppb. The projected emissions from all future OCS activities are between 0 and 40 percent above existing OCS emission rates. The highest contributions from the cumulative OCS emissions would, therefore, be within the range predicted in the above modeling study. The projected emissions for the proposed 5-year program for the Gulf of Mexico are only about 10 percent of the projected cumulative emissions. The contributions from the proposed 5-year program on ozone would, therefore, be small.

The implementation of the new 8-hour Federal standard for ozone may affect the importance of OCS emissions on ozone levels. The revised standard, which is 0.08 ppm for the 8-hour average ozone concentration, is more stringent than the previous 1-hour standard. It is likely that a number of Gulf coastal areas that presently meet the 1-hour standard will not meet the new 8-hour standard. These may include a number of counties in coastal Louisiana, Mississippi, Alabama, and Florida. An analysis of the GMAQS modeling results suggested that OCS emissions contribute a maximum of about 5-6 ppb to the total ozone concentrations in those areas in southeast Texas and Louisiana where the predicted 8-hour average levels exceeded 0.08 ppm (Herkhof and Marshall, 1998). As with the 1-hour standard, the highest contributions were realized in only a small geographic area at any particular time. The projected emissions from the proposed 5-year program are only a fraction of the cumulative OCS emissions. The contributions from the proposed 5-year program to ozone levels would, therefore, be small. However, the potential effects of OCS emissions on 8-hour average ozone levels will be studied in the near future. A new modeling analysis will be conducted using OCS emissions generated for the year 2000.

Ambient ozone concentrations presently exceed the Federal standard in a number of Gulf coastal areas. The contribution from all existing OCS emissions is small (at most about 2% of the total concentrations). Any additional contributions from the proposed 5-year program would be small. The impacts on ozone would, therefore, be minor.

Visibility

Gaseous and fine particulate matter in the atmosphere can potentially degrade atmospheric visibility. The most important source of visibility degradation is from particulate matter in the 1- to 2-micron size range. These particles are directly emitted into the atmosphere through fuel burning. However, other sources arise through chemical transformation of NO_2, SO_2, and VOC into nitrates, sulfates, and carbonaceous particles. Existing visibility in the eastern United States, including the Gulf States, is impaired due to fine particulate matter containing primarily sulfates and carbonaceous material. High humidity is an important factor in the Gulf coastal areas in visibility impairment. The absorption of water by the particulate matter makes them grow to a size that enhances their ability to scatter light and, hence, aggravates visibility reduction. The estimated natural mean visibility in the eastern United States is 60-80 miles (National Park Service, 1994). The observed mean visual range is 10 miles or less in large portions of coastal Louisiana, Mississippi, and Alabama. In the Texas coastal areas, the average visibility is 20-25 miles. In the Gulf States, between 50 and 60 percent of the human-induced visibility degradation is attributed to sulfates particles, while about 20 percent of the visibility degradation is from carbon-based particles.

Visibility degradation in large urban areas, such as Houston, can be especially pronounced during air pollution episodes. In some severe cases it may hinder navigation by boats and aircraft. Degraded visibility also adds to the perception by the observer of bad air quality even when monitors do not record unhealthful pollutant levels. Visibility is considered to be an important resource in many Federal Class I areas, including the Breton National Wilderness Area.

Because future air emissions from all sources in the area are expected to be at about the same level or somewhat less than present-day values, impacts on visibility would be moderate.

The application of visibility screening models to individual OCS facilities has shown that the emissions are not large enough to significantly impair visibility. It is not known to what extent aggregate OCS sources contribute to visibility reductions. However, the individual emission sources from the proposed 5-year program are relatively small and scattered over a large area, and it is not expected that, as a whole, they would have a measurable impact on visibility. The emissions associated with OCS oil and gas activities are a relatively small fraction of all emissions in the region. Furthermore, the projected emissions from the proposed 5-year program are expected to be only about 10 percent of the cumulative OCS oil- and gas-related emissions. The impacts from the proposed 5-year program on visibility would be negligible.

Small accidental oil spills would cause small, localized increases in concentrations of VOC due to evaporation of the spill. Most of the emissions would occur within a few hours of the spill and will decrease drastically after that period. Large spills would result in emissions over a large area and a longer period of time. A discussion of the effects of oil spills on Gulf of Mexico air quality is presented in Section 4.3.2.2. The toxic components evaporate almost completely within a few hours after the spill occurs. Ambient levels of these compounds arising from a spill do not pose a health hazard. If a large oil spill were to occur in an area where there were routinely large emissions of atmospheric pollutants, there could be a temporary increase in ozone levels if meteorological conditions were conducive to ozone formation.

In situ burning of a spill results in emissions of NO_2, SO_2, CO, and PM_{10} and would generate a plume of black smoke. Air quality impacts from in situ burning are discussed in Section 4.3.2.2. Ambient measurements of pollutants during a number of in situ burn experiments indicated that levels were within Federal standards (Fingas et al., 1995; McGratten et al., 1995).

In summary, any air quality impacts from oil spills would be localized and of short duration. Emissions do not appear to be hazardous to human health. The impacts from in situ burning are also very temporary. Pollutant concentrations would be expected to be within the NAAQS. The air quality impacts from small or large oil spills and in situ burning would, therefore, be minor.

Conclusions: The cumulative air quality impacts due to all emission sources in the region range from **minor** to **major**. Air quality impacts are **moderate** to **major** in areas where ozone levels exceed the Federal standards. Small and large oil spills would have a **minor** impact on air quality. Routine emissions associated with the proposed 5-year program, including small oil spills would have **minor** impacts on air quality. Large oil spills associated with the proposed 5-year program would have **minor** impacts on air quality.

4.8.2.3. Marine Mammals

The cumulative scenario assumes increased levels of activity, over time, in the Gulf of Mexico, particularly in the central and western Gulf of Mexico. This represents an increase in the number of platforms and an even larger increase in the number of development and production wells. Impact producing factors associated with oil and natural gas activities in State waters would be similar to those factors discussed for Federal OCS waters. Additional non-OCS oil and gas activities that contribute impacts to marine mammals include dredging and marine disposal; coastal and community development; discharging municipal wastes and effluents; transportation by domestic and foreign tankers NASA/USDOD/USDOT activities; and commercial, recreational, and live capture (for public display and scientific research) fisheries.

What we do know about marine mammal mortality in the Gulf of Mexico comes from stranding data. Stranding data collected by the U.S. Department of Commerce (USDOC), National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS) (Southeast U.S. Marine Mammal Stranding Network unpublished data), and the Florida Fish and Wildlife Commission probably underestimate the extent of mortality and serious injury to marine mammals because not all marine mammals that die or are seriously injured may wash ashore. A total of nine sperm whale (*Physeter macrocephalus*) strandings were documented in the northern Gulf of Mexico during 1987-1994. One of the whales had parallel cuts posterior to its dorsal ridge, which were believed to be caused by the propeller of a large vessel. Except for that whale, none of the strandings were documented as likely to be caused by fishery interaction or other human-related causes. Human-related manatee (*Trichechus manatus latirostris*) deaths are generally the cause of one-fourth to one-third of the documented manatee deaths. The vast majority are caused by collisions with watercraft, followed by entrapment by flood gates and navigation locks. The level of dolphin mortality in the Gulf of Mexico due to past or current, direct human-caused mortality is unknown. Two documented strandings of Atlantic spotted dolphins (*Stenella frontalis*) in the northern Gulf of Mexico during 1987-1994 were classified as being likely caused by fishery interactions. An annual mean of eight bottlenose dolphins (*Tursiops truncatus*) stranded on the Florida Gulf Coast during the period 1988-1993 (8.9% of the total strandings) showed signs of human interaction such as fishing net entanglement, mutilation, and gunshot wounds.

Regarding marine mammals and fishery interactions, Section 118(b) of the Marine Mammal Protection Act (MMPA), as amended in 1994, mandates that commercial fisheries reduce the incidental mortality and serious injury of marine mammals to insignificant levels by April 2001. While those levels have not yet been achieved, progress in that direction is occurring. Commercial fisheries may accidentally entangle, drown, or injure marine mammals during fishing operations. Other direct human interactions with marine mammals include an increasing number of commercial opportunities to view, feed, or swim with marine mammals. While unintentional, these activities may cause animals to relocate from preferred habitat; result in injury from people wishing to touch or prod the animals; debilitate animals by feeding them inappropriate, contaminated, or spoiled food; or encourage the animals to interact with humans and engage in other activities and become pests. While no immediate injury may result, marine mammals may become habituated to people and boats, exposing them to risks they may not otherwise face.

All living marine mammals have been exposed to the multiple chemical compounds and trace elements introduced into the coastal and marine environments by human activities through runoff, dumping, leaking, and atmospheric transport. Most marine mammals are high order predators (except baleen whales and sirenians) that can be exposed to high levels of some contaminants through biomagnification (increasing levels of contaminants up the food chain). Chronic effects of chemical contamination are likely to include lesions, endocrine disruption, and immunosupression.

A number of OCS oil and natural gas activities and non-OCS activities may impact marine mammals (both listed and nonlisted) in the Gulf of Mexico. Impacts on marine mammals in the Gulf of Mexico from routine OCS activities associated with the proposed program (operational discharges and wastes, vessel traffic, noise, and structure removal) are discussed in Section 4.3.2.3. Table 4-1a and Table 4-6a present the scenario elements for routine activities associated with the proposed program and the cumulative case (ongoing and possible future Federal OCS activities).

Cumulative OCS operational discharges, generated on a monthly basis, are expected to increase significantly in the Western and Central Planning Areas and to remain about the same level in the Eastern Planning Area as for the proposed program. An unknown but substantial amount of wastes would be discharged into nearshore waters from State oil and gas activities. These additional waste fluids would be treated or monitored for relative levels of contaminants prior to discharge, and plumes of these released wastes would mix rapidly with ambient seawater and would be diluted. It is expected that cetaceans will periodically interact with offshore discharges; however, any effects are expected to be sublethal. Indirect effects via food sources are not expected due to offshore dilution and dispersion.

Operational discharges would also be contributed by non-oil and gas activities, including dredging and marine disposal, municipal wastes, extraction activities, transportation, and NASA/USDOD/USDOT activities. Coastal sources of contaminants (industrial and municipal effluents and agricultural runoff) will continue to degrade offshore water quality over time. Eutrophication of coastal waters from inputs of nitrogen and phosphorus will continue causing ecosystem changes. Increasing algal blooms and biotoxin poisoning in marine mammals appears to be a direct result of degraded coastal water quality. The frequency and scale of unusual mortality events in marine mammals appears to have increased over the past 25 years. These mortality events have involved manatees and bottlenose dolphins along the Gulf of Mexico coasts. In 1999, at least 87 bottlenose dolphins stranded along the Florida Panhandle from September through December. This number is more than eight times the previous high for this period. The apparent cause of the bottlenose dolphin deaths was a toxic algal bloom. Contaminants may affect the mammals' immune systems making them more susceptible to bacterial, viral, and parasitic infections and biotoxins. Previous unusual bottlenose dolphin mortality events occurred in 1990 (Matagorda Bay), 1992 (East Matagorda Bay), and 1994 (east Texas/Louisiana).

The long-term threat to the manatee population is habitat degradation from flood control efforts, channelization, coastal development, and pollution. These activities damage or destroy seagrass beds (essential feeding areas) and reduce the number of secluded areas for resting, calving, and nursing. Bottlenose dolphins in Sarasota Bay, Florida, appear to use less-altered areas more frequently (Wells, 1992). Artificial passes in southern Texas may have increased habitat for bottlenose dolphins (Leatherwood and Reeves, 1983). Habitat alteration may potentially disrupt social behavior, food supply, and health of cetaceans in the Gulf of Mexico. Such activities may stress the animals and cause them to avoid traditional feeding and breeding areas or migratory routes.

It is expected that the incremental added impacts from OCS discharges to listed and nonlisted marine mammals would remain negligible as a result of the relatively low concentrations of discharged contaminants within the open-ocean environment.

Service vessels comprise the greatest amount of marine traffic associated with OCS activities. The numbers of OCS vessel trips per week associated with OCS cumulative scenario range from maintaining the number assumed under the proposed action to doubling that number, and are reflected in Table 4-6a. In addition, there are other non-OCS activities that involve vessel operations (i.e., dredging and marine disposal, extraction activities [nonenergy minerals, oil and gas from State waters], transportation [domestic and foreign tankers], and NASA/USDOD/USDOT operations), some of which occur at considerably higher frequency levels than the proposed action. Further, while many of these operations are continuous, vessel activity in support of these operations may or may not be intermittent. Increased vessel traffic could increase the probability of collisions between ships and marine mammals, resulting in injury or death to some animals. Most cetacean species in the Gulf are distributed in deeper waters, on or beyond the continental shelf break. The probability of collisions in these waters is higher. It is expected that the extent of service vessel traffic presented in the cumulative scenario would most likely result in the incidental take of cetaceans through active avoidance behavior or displacement of individuals or groups. The extent of displacement will depend on the mammal's age, sex, psychological status, physiological condition, and behavioral or social activity. The net result will depend on the percentage of the population affected, ecological importance of the area disturbed, and the mammal's ability to accommodate the disturbance. Overall, effects are expected to be sublethal and constitute a short-term, temporary impact. Smaller delphinids may approach vessels in transit to bow-ride. The incremental increase in vessel activity under the proposed action is small compared to vessel activity under the OCS and non-OCS cumulative scenarios. Expected incremental impacts to listed marine mammals in the Gulf of Mexico from OCS service vessel traffic would remain minor.

The single largest contributor to sound in the ocean is from ships. Noise in the Gulf of Mexico originates from a variety of sources as described in Section 3.1.1.5 and 4.3.2.3. Vessel traffic as a source of transient noise is associated with several non-OCS activities, including dredging and marine disposal, extraction activities (nonenergy minerals, oil and gas from State waters), transportation (domestic and foreign tankers), and NASA/USDOD/USDOT operations. While many of these operations are continuous, vessel activity may or may not be intermittent. Noise derived from OCS helicopters and surface vessels is transient; related impacts would be manifested primarily as a startle response or avoidance behavior by marine mammals. These effects are sublethal and of a temporary nature. Therefore, incremental impacts from noise generated by OCS transportation sources on marine mammals from the combined activities of OCS cumulative, and non-OCS cumulative scenarios are considered minor.

The effects of noise from seismic survey activities on marine mammals have been discussed in Section 4.3.2.3. The vast majority of seismic surveys use air and water guns to generate pulses, and it is assumed that these methods will be used in seismic surveys as a result of the proposed action, future Federal OCS actions and State oil and gas activities. Though not specified, it is assumed that the level of seismic activity associated with the proposed program would remain at levels similar to those associated with the current program and perhaps increase in future programs. Nevertheless, the impacts to marine mammals from these additional seismic surveys are still assumed to be temporary and minor.

Among the non-OCS activities, only extraction operations (i.e., nonenergy minerals, oil and gas production from State waters) represent additional sources of drilling and production noise. Noises associated with drilling and production activities are generally of low frequency, relatively weak in intensity, and temporally transient, as detailed previously. Therefore, impacts from platform noise to marine mammals resulting from the contribution of the proposed action to all other noises considered in the cumulative analysis are expected to be negligible.

The possible impacts of explosive platform removals to marine mammals are described in Section 4.3.2.3. The proportion of platforms removed using explosives is assumed to be relatively constant with current removals (about two thirds of removals). Similarly, platform removal may also occur in State waters, when extraction operations reach the end of their productive life. For this analysis, it is assumed that all of these activities would be subject to mitigating guidelines (similar to the guidelines developed through the Endangered Species Act (ESA) consultations and the MMPA) for the use of explosives for platform or structure removal. Mitigating measures require qualified observers to monitor the detonation area for protected species prior to and after each detonation. Following these mitigating measures, it is expected that the impacts to marine mammals from explosive removals of structures associated with the cumulative scenarios would be negligible.

Applicable factors and activities associated with potential accidents in the cumulative scenario that may impact listed and nonlisted marine mammal species in the Gulf of Mexico include the presence of spilled oil and oil dispersant chemicals, and noise associated with oil-spill response activities.

The effects of spilled oil on marine mammals have been discussed in Section 4.3.2.3. The locations and sizes of oil spills associated with the cumulative scenario are presented in Table 4-6c. In general, both the probability and number of oil spills increase. In addition, large oil spills from import tankers become a consideration under the cumulative scenario. While not presented in Table 4-6c, spills in State waters will contribute to the number and probability of shallow spills. Oil spills greater than 50 bbl resulting from import tankering, the proposed action, prior and future OCS sales, and State activities are still infrequent events that will periodically contact cetaceans, particularly in shallow waters of the central and western Gulf of Mexico. A comparison of the distributions of marine mammals in the Gulf of Mexico and the location of oil spills suggests that spilled oil could directly contact and perhaps directly or indirectly impact both manatees in shallow water and sperm whales in deep water within the Gulf of Mexico. The comparison of the distributions of nonlisted marine mammals in the Gulf of Mexico and the oil-spill assumptions of the cumulative scenario also suggests an increased possibility that spilled oil could directly contact and perhaps directly or indirectly impact these species. Oil spills have the potential to cause acute and chronic (long-term, lethal and sublethal oil-related injuries) effects on marine mammals. The impact level associated with the incremental addition of the proposed action to additional accidents is expected to be moderate.

Oil-spill response activities that may affect marine mammals and their expected impacts have been discussed in Section 4.3.2.3. Despite the increase in spills associated with the addition of the proposed action to the assumed prior and future OCS and State oil spills, the use of these chemicals and cleanup activities is expected to be localized and infrequent. Therefore, potential impacts to marine mammals resulting from the incremental addition of oil-spill response activities are expected to be negligible.

Conclusion: The overall impact to marine mammals from routine activities are expected to be **minor**. If large oil spills were to occur from OCS operations and non-OCS activities in the Gulf of Mexico, impacts would be **moderate**. Impacts to marine mammals as a result of oil-spill response activities would be **negligible**. The proposed action represents a **minor** contribution to impacts resulting from the cumulative potential oil spills and activities considered above.

4.8.2.4. Terrestrial Mammals

Potential impacts to listed terrestrial mammals resulting from OCS activities in the Gulf of Mexico are described in Section 4.3.2.4. Listed species considered in this analysis (several coastal beach mice species, Florida vole) are limited to mature coastal dune habitats (Alabama and northwest Florida coasts) and are generally located within protected areas buffered from contact with OCS industry infrastructure. The OCS construction-related activities would generally not affect beach mouse habitat enough to add to the heavy pressures being exerted on their populations by dredge and fill activities which may disturb sand dune habitats, and predation by domestic animals (cats and dogs) and by feral animals. The contribution of the proposed action to cumulative impacts on the listed species of terrestrial mammals is negligible.

Impact producing factors from potential accidents during OCS activities that may impact listed terrestrial mammals in proximity to the Gulf of Mexico are discussed in Section 4.3.2.4. Spill impacts, particularly from shallow-water oil spills within the eastern Gulf, are discussed in this earlier section. However, these species are generally restricted to areas of secondary inshore dune habitats, and spilled oil released during a shallow-water accident would, therefore, not reach these habitats unless the accident occurred during a period of high storm surge. In addition, these preferred and critical habitats are clearly known, and current oil-spill contingency plans require that beach cleanup activities are designed to minimize impacts to these habitats and to focus activities within the intertidal zone of the impacted beach. Based on characteristics of OCS and non-OCS cumulative accidents noted previously (Table 4-6a and Section 4.8.1), incremental impacts to listed terrestrial mammal species from potential accidents associated with the proposed action, and the OCS and non-OCS cumulative scenarios would be negligible.

Conclusion: The overall impact to endangered terrestrial mammals from all routine activities taking place in and around their habitats would be **major**. The overall impact from large oil spills in State and Federal waters which come into contact with terrestrial mammal habitat would be **minor**. The contribution of the proposed action to impacts on terrestrial mammal habitat and animals would be **negligible**.

4.8.2.5. Marine and Coastal Birds

This cumulative analysis considers the present population status and migratory habits of listed and nonlisted marine and coastal birds, and the effects of impact-producing factors that may occur and adversely affect those populations. These factors include commercial and recreational offshore and coastal activities; geographical and meteorological conditions; State oil and gas activity; crude oil imports by tanker; and the proposed action, prior, and future OCS sales. The cumulative impact-producing factors from routine OCS operations in the Gulf of Mexico are presented in Table 4-6a. Non-OCS cumulative scenario elements considered in this analysis are reviewed in Section 4.8.1.2. Impacts to marine and coastal birds as a result of the proposed action are discussed in Section 4.3.2.5. Impacts of routine operations from prior and future OCS lease sales are similar to the proposed action. The home ranges, habitats, and life strategies of listed species coincide with those of nonlisted marine and coastal birds (Section 3.1.2.3). Therefore, the impact producing factors considered under the cumulative case for listed marine and coastal birds are the same as those for nonlisted birds.

Operational discharges would occur from OCS and non-OCS activities, including (1) dredging and marine disposal, (2) municipal wastes and other effluents, (3) other extraction activities (non-energy minerals, oil and gas from state waters), (4) transportation of oil and gas (domestic transport, foreign imports), and (5) NASA/USDOD/USDOT activities. With the exception of transportation of oil and gas and NASA/USDOD/USDOT operations, all other non-OCS activities occur in nearshore waters. Based on the low concentrations of discharged contaminants within an open ocean environment, it is expected that additional impacts to eastern brown pelicans or other listed seabirds associated with the release of operational discharges from the proposed action are negligible.

Because they are the species most closely associated with nearshore waters, the brown pelican (*Pelicanus occidentalis*), piping plover (*Charadrius melodus*), and snowy plover (*Charadrius alexandrinus*), can become entangled in monofilament fishing line, netting, six-pack yokes, etc., which may result in injury or mortality. Ingestion of plastic and styrofoam materials may cause internal blockage, resulting in injury or mortality (Centaur Associates, Inc. and Center for Environmental Education, 1986). Ingested plastic may impair feeding activity where plastic reduces the food storage volume of the stomach and limits the accumulation of fat reserves essential for reproduction and migration (Ryan, 1988). By complying with special prohibitions by the MMS and the International Convention for the Prevention of Pollution from Ships (MARPOL), Annex 5, Public Law 100-220 (101 Statute 1458), which prohibits the disposal of any plastics at sea or in coastal waters, lessees can greatly reduce, if not eliminate, future OCS-related loss of trash and debris. The effects of OCS oil/gas-related trash and debris from the proposed action, prior and future OCS sales, and State oil and gas activity, on the brown pelican, piping plover, and snowy plover are expected to be undetectable and sublethal.

Coastal storms and hurricanes cause flooding and destruction of nesting, resting, and feeding areas, resulting in losses of listed birds and their critical habitats. High levels of oil and organic chemical contamination in the river runoff into the northern Gulf of Mexico cause direct mortality of listed avian species and indirect food loss. Collision with power lines and supporting towers causes additional losses of raptors such as the bald eagle (*Haliaeetus leucocephalus*) (Avery et al., 1980). The combined impact of coastal storms and hurricanes, contamination by Mississippi River runoff, and, in the case of endangered raptors, collision with power lines and supporting towers will be a decline in populations or species of listed birds. This will result in a change in distribution and/or abundance of birds in localized areas of the Gulf of Mexico. Should these factors cease adversely affecting threatened and endangered marine and coastal birds, the populations or species will return to their former level within one to two generations.

Comprehensive information on oil and gas activities in State waters in the Gulf of Mexico Region has not been compiled. However, a number of activities associated with State oil and gas operations could impact marine and coastal birds. In addition to those discussed in Section 4.3.2.5, impact producing factors would include refining and processing activities, and disposal of oil field wastes. The storage of oily industrial waste in open pits, within some southern States, may seriously deplete populations of birds migrating to the Gulf of Mexico. Migrating listed birds, particularly bald eagles, are especially susceptible because they apparently will feed on dead migrating waterfowl and ingest oiled carrion. It is assumed storage of oily waste in pits accessible to migrating waterfowl and listed raptors will continue. Sublethal effects on listed birds are expected to occur through ingestion of oiled carrion and ingestion of oil during preening. It is expected that the storage of oily waste in pits will cause a decline in listed raptor populations or species resulting in a change in distribution and/or abundance of those birds in the Gulf of Mexico. Should storage of oily waste in accessible pits cease, the affected populations or species would stabilize (not increase) within two generations.

The Federal Aviation Administration's Advisory Circular 91-36c prohibits the use of fixed-wing aircraft and helicopters at certain elevations (lower than 150 m and 300 m, respectively) while migratory listed birds are in the vicinity of numerous national wildlife refuges in the Gulf of Mexico (October 15-April 15). These wildlife refuges provide important feeding, resting, and nesting areas for many listed birds, but especially for the whooping crane (*Grus americana*) in coastal Texas. Although an incident between OCS-related traffic and listed birds may occur and be disruptive, at worst the effect would be sublethal, and temporary, lasting less than a few hours. It is assumed that greater than 95 percent of the OCS-related oil and gas traffic will occur in and out of existing port areas that are well away from critical habitats for feeding, resting, or nesting areas of listed species and, therefore, will not disturb these birds.

Disturbance of habitats for feeding, resting, or nesting due to pipeline landfalls and onshore construction could result in a reduction or displacement of birds that use the habitats. It is estimated that as many as five new pipeline landfalls will be constructed in the Western and Central Gulf of Mexico Planning Areas and two to three in the Eastern Gulf of Mexico Planning Area in support of oil and gas activities over the next 60 years. While the landfalls and piping through coastal areas will affect marine and coastal bird habitat (Section 4.8.2.8), it is assumed that pipeline landfalls will not affect any listed birds or their habitat due to the recognition and prohibition of alteration within critical habitats. Construction of new shore facilities in the Central and Western Planning Areas may require dredging or filling of coastal habitats. The altered habitat plus surrounding areas may no longer be suitable as feeding, resting, or nesting habitat for listed birds. There are regulatory difficulties in permitting new construction projects in wetlands and higher costs when compared to construction in upland areas. It is assumed that construction of these facilities will be done on uplands and will not disturb wetland areas of the brown pelican, piping plover, and whooping crane. However, since there are prohibitions against construction in upland areas considered critical for bald eagles, it is assumed that construction of pipe yards and terminals will not disturb bald eagles. It is expected that construction of shore facilities would not affect listed birds.

In summary, a number of activities such as habitat loss, State oil and gas activities, OCS helicopter and vessel traffic, pipeline landfalls and construction of coastal facilities, coastal urbanization, commercial and recreational offshore activities, and meteorological conditions may adversely affect marine and coastal birds. It is expected that habitat loss and reproductive failure will cause a decline in bird populations or species, resulting in a change in distribution and/or abundance of threatened and endangered marine and coastal birds in the Gulf of Mexico.

The probabilities of spill occurrence for the cumulative case are shown in Table 4-6c. The most likely source of offshore spilled oil is pipelines, which are concentrated in the central Gulf. Considering the locations of oil pipelines and platforms offshore, and the pattern of coastal ocean currents, the most likely location for contact, should it occur from offshore spills, is along a stretch of coast extending from western Louisiana to eastern Texas. It is assumed that as much as 75 percent of the original volume of offshore spilled oil would be lost as a result of weathering processes before any resulting slick could contact the coast. Numerous large spills could occur in the Gulf of Mexico during the 60 years of the cumulative scenario from foreign tankers transporting oil to Gulf Coast ports (Table 4-6c). Assuming that a number of small spills do occur near coastal estuaries, the most likely location for contact, should it occur from small oil spills, is along a stretch of coast extending from western Mississippi to eastern Texas. No small spills are assumed to contact estuaries in the northeastern Gulf. If oil spills were to occur, it is likely that there would be contact between listed birds and spilled oil. Because they are the listed species most closely associated with nearshore waters, the brown pelican, piping plover, snowy plover, and bald eagle in the northeastern Gulf are the species most likely to be contacted by a 1,000-bbl or greater oil spill. The bald eagle, which is restricted to upland and wetland areas 30-50 miles from the Gulf's north-central and northeastern coastline, is least likely to be contacted by any oil spills. The extent and severity of effects from oil spills of any size would be lessened by improved coastal oil-spill contingency planning and response, deterrence/scaring of birds away from the immediate area of an oil spill, and increased percentage of survival from rehabilitation efforts. In the event that an oil spill occurs and contacts the brown pelican, piping plover, snowy plover, and bald eagle, it is expected that the effects would primarily be sublethal with few mortalities. In the event that oil spills of any size should occur in critical habitats for feeding, resting, or nesting (such as inshore, intertidal, and nearshore areas), sublethal effects are expected.

Oil-spill response activities that may affect coastal and marine birds involve the application of dispersant chemicals to spilled surface oil and coastal cleanup operations, including associated disturbance (Section 4.3.2.5). Based on the proposed action's spill characteristics (e.g., few total spills, from various spills sites, including offshore deep water), as well as the corresponding characteristics of spills under the OCS scenario and relative contribution of non-OCS spills, the incremental impact of spills assumed in the proposed action to the OCS and non-OCS cumulative spill scenarios would be negligible.

***Conclusion*:** Under the cumulative scenario, a decline is predicted in listed marine or coastal bird population(s) or species, resulting in a change in distribution and/or abundance in the Gulf of Mexico Region. Incremental impacts to coastal and marine birds that may be attributable to routine operations associated with the addition of the proposed action to the cumulative scenario would be **minor**. Marine and coastal birds affected by spilled oil should be replaced through natural recruitment within two to three generations. The incremental contribution of the proposed action to the cumulative impact would be **negligible** because there should be no discernible decline in listed or nonlisted bird populations or species, and no change in distribution or abundance, from the proposed action.

4.8.2.6. Fish Resources

4.8.2.6.1. Threatened or Endangered

Gulf Sturgeon

Changes in routine operations brought about by adding the proposed action to the OCS and non-OCS cumulative scenarios would occur variably among the impact producing factors (i.e., physical emplacement, presence, and removal of facilities; discharges and wastes; noise; and abandonment/decommissioning) that may affect the Gulf sturgeon. The Gulf sturgeon occurs only in the eastern and central Gulf of Mexico. Adult sturgeon spend November through March in estuarine or shelf waters where they feed on benthic fauna (Sulak and Clugston, 1998; Fox et al., 2000). Bottom area disturbed by new platforms and new pipelines in the Eastern Gulf of Mexico Planning Area and in the Central Gulf of Mexico Planning Area (Table 4-6a) may have impacts on the Gulf sturgeon's estuarine and coastal benthic prey. Drill cuttings and associated fluids in the Eastern and Central Gulf of Mexico Planning Areas (Table 4-6a) could smother potential benthic food sources for adult Gulf sturgeon as well as change the sediment particle size in a small area; this would reduce the amount of desirable habitat for some benthic invertebrates.

Short-term increases in turbidity from bottom disturbances and increases in noise levels from platform and pipeline installation and drilling activities may disrupt feeding behavior and drive some of the adult Gulf sturgeon away. Platform removals with explosives may kill some adult Gulf sturgeon.

In addition to oil and gas activities, Gulf sturgeon are affected by commercial fishing, water quality degradation, coastal and upland development, dredge and fill activities, and damming of major spawning rivers. Even though it is illegal to fish for Gulf sturgeon, there is a significant incentive for poaching of the adults. Their eggs are highly prized on the illegal market as caviar. Dredging and fill activities in the spawning rivers have the potential to smother the benthic eggs of the Gulf sturgeon.

Increased barriers to major spawning sites may result in fish reproducing in less desirable locations. The eggs and fry are more susceptible to other fish and invertebrate predators as well as anthropogenic effects such as artificially increased water temperatures due to the release of cooling water from power plants and exposure to pesticides and heavy metals.

Oil spills in the Eastern and Central Gulf of Mexico Planning Areas have the greatest potential to impact Gulf sturgeon populations. Western Gulf of Mexico Planning Area spills are less likely to reach estuarine and shelf habitat of the adult sturgeon. Under the cumulative scenario, a number of shallow spills are assumed to occur in the Eastern and Central Planning Areas (Table 4-6c). Any shallow spills have the potential to impact on Gulf sturgeon. The eggs are benthic and most likely would not come into direct contact with oil from a spill. Upon hatching, the larvae move into the water column but are up in the far freshwater reaches of the rivers and are not likely to come into contact with a spill. Adult sturgeon are benthic feeders and most likely would not come into contact with surface oil. Adults could potentially ingest tar balls.

Non-OCS spills in the eastern and central Gulf of Mexico (Table 4-6c) could have similar impacts to those mentioned in the previous paragraph. Many of the spills are likely to occur in deep water and will not come into contact with the estuarine and coastal habitat during the approximately 4 months (November-February) when the adult sturgeon are present and feeding.

Conclusions: The cumulative impact from routine OCS and non-OCS activities is expected to be **minor**. The overall impact to Gulf sturgeon from all large spills including those associated with the Federal OCS, State waters, and imports is expected to be **minor**. The incremental impact to Gulf sturgeon from routine activities and spills associated with the 2002 OCS Program could be **negligible** to **minor**.

4.8.2.6.2 Nonendangered

Other Fish Resources

As previously outlined in Section 3.1.2.4. there are numerous fish and marine invertebrate species that inhabit different niches throughout the surface waters, water column, and benthic environment. Cumulative routine activities will have varied effects on these fish populations depending on their habitat and life history. Activities that temporarily disturb sediments and increase turbidity include installation of new pipelines and platforms, and discharges of drill cuttings and associated fluids (Table 4-6a). This could cause soft-bottom fish such as shrimps, Atlantic croaker, sand seat rout, Atlantic bumper, sea robins, and sand perch to temporarily move from the area. Reeffish species such as snappers, groupers, grunts and squirrelfishes may also move from areas of increased turbidity. Demersal eggs and benthic prey of some of these fish species may be smothered (Gulf of Mexico Fishery Management Council, [GMFMC], 1998). Some habitat such as seagrasses may be damaged because of sedimentation from these routine activities.

Many reef species as well as highly migratory species use platforms as habitat. Removal of platforms by explosives will reduce available substrate and structures for these fish and some of their prey species. Some fish will be killed in the process of these platform removals. The greatest number of platforms anticipated to be removed using explosives (1,860-2,500 platforms) will occur in the Central Gulf of Mexico Planning Area.

Highly migratory species such as tunas and billfish may be affected by several routine activities. Elevated noise levels from increased vessel traffic and drilling activities may cause these fish to migrate prematurely from a particular area. The addition of new platforms may act as fish attracting devices (FAD's). There has been some speculation that an increase in FAD's could impact the migration patterns of highly migratory species.

Non-OCS routine activities are similar to those discussed in Section 4.8.2.6.1. These impact producing factors may negatively influence fish resources in various life stages and habitats. In addition to those previously discussed, commercial fishing practices that are indiscriminate, such as some types of trawling and pots, are responsible for significant amounts of by-catch and juveniles of many fish species. These types of fishing practices can damage future year classes, reduce available prey species, and destroy benthic habitat for many Gulf of Mexico fish resources.

A shallow pipeline spill in the Eastern Gulf of Mexico Planning Area could occur in the vicinity of the pink shrimp assemblages (Section 3.1.2.4.), which include fish species such as Atlantic bumper, sand perch, and pigfish. However, adults of these species are demersal and would either not come into contact with the oil once it reached the surface or would move away from it at the spill site.

Spills in the Central Gulf of Mexico Planning Area (Table 4-6c) may affect fish in the brown shrimp assemblage. Some of the fish species in this assemblage include the longspine porgy, sea robins and the dwarf goatfish. These fish are also largely demersal as adults and would avoid surface oil.

Any of these spills reaching shallow seagrass, estuarine, or coastal marine habitat could have a significant impact on fish species that use these areas as juvenile nursery or spawning habitat. Coastal pelagic fish throughout the Gulf of Mexico may come into contact with surface oil but would most likely move away from the area.

Highly migratory species may come into contact with deepwater surface spills. However, they would actively move away and avoid these areas. If they were to occur, deepwater surface spills would impact invertebrate eggs and larvae. They could also impact neuston communities such as jellyfish species (Class Scyphozoa), Portuguese Man-of-War (*Physalia phyysalia*), by the wind sailor (*Velella velella*) and *Sargassum* and its associated vertebrate and its invertebrate community. These organisms could not move away from the oil and would be injured or killed.

Effects of these spills would be similar to those described for OCS activities. More large spills are likely to occur from import tankers in the Gulf of Mexico than from OCS activities (Table 4-6c).

Conclusions: The cumulative impact to nonendangered fish resources from routine OCS and non-OCS activities would be **minor**. The overall cumulative impact from large oil spills on the Federal OCS or State waters and from import tankering would be **minor,** though some localized coastal impacts could be more serious. The incremental impact from routine activities and accidents from the 2002 OCS Program would be **minor**.

4.8.2.7. Sea Turtles

Impact producing factors and activities associated with oil and gas operations that may affect sea turtle species in the Gulf of Mexico are described in Section 4.3.2.7. These impact producing factors are the same as for current and future OCS activities and State oil and gas activities. Additional impact producing factors considered in this cumulative analysis include dredge and fill operations, water quality degradation, natural catastrophes, agricultural pollution, commercial fishing, hopper dredge operations, and recreational boat traffic. Marine turtles are vulnerable to harm from human activities throughout their migratory ranges, particularly because of their wide-ranging movements in coastal waters. The National Research Council (NRC) reviewed major activities that affect marine turtles including commercial fishing; hopper dredging; pollutant discharge; ingestion of or entanglement in debris; nearshore boat traffic; and contact with foreign, inshore, or processed oil (NRC, 1990b). Information from that review will be considered in this cumulative analysis.

The NRC (1990b) concluded that capture and drowning in commercial fishing gear, particularly shrimp trawls, was the largest cause of death for sea turtles in the United States and the Gulf of Mexico. Year-round use of Turtle Excluder Devices (TED's) on shrimp trawls from North Carolina to Texas was legislatively mandated in 1994 to decrease turtle deaths. Turtles are also incidentally captured in pelagic longline, paired trawl, gill net, and set-net fisheries, but these sources of deaths are not fully documented. Witzell (1984) estimated that 79.6 percent of the observed take (57 sea turtles) by the Japanese tuna longline fleet in the Gulf of Mexico and the Atlantic were leatherbacks. Collectively, unattended nets set in shallow waters and fisheries other than shrimping are the second largest source of mortality to sea turtles (NRC, 1990b). Sea turtle mortality associated with these fisheries varies in response to seasonal abundance of turtles and to the intensity and timing of the fishing effort. Another consequence of fishing operations is entanglement of turtles in discarded fishing gear. Entanglement reduces turtle mobility, increasing their susceptibility to vessel collisions, incidental capture, and predation. Entanglement can also result in drowning and constriction of limbs leading to amputation and then death from infection.

Dredge-and-fill activities occur in many of the nearshore seasonal habitats of marine turtles in the southeastern United States and in other areas. Operations range in scope from propeller dredging by recreational boats to large-scale navigation dredging and fill for land reclamation. Hopper dredging has caused turtle deaths in coastal areas, including the Cape Canaveral Ship Channel in Florida and the King's Bay Submarine Channel in Georgia (Slay and Richardson, 1988), but deaths in the Gulf of Mexico have not been estimated.

Sea turtles frequent coastal areas such as algae and seagrass beds to seek food and shelter (Carr and Caldwell, 1956; Hendrickson, 1980). These nearshore areas are used by juvenile Kemp's ridleys in Louisiana (Ogren, 1989) and in Texas (Manzella and Williams, 1992) and by green, loggerhead, and hawksbill turtles throughout the Gulf. Submerged vegetated areas may be lost or damaged by activities that alter salinity, increase turbidity, or disturb natural tidal and sediment exchange. Natural catastrophes, including storms, floods, droughts, and hurricanes, can also substantially damage sea turtle habitats and nesting beaches.

Construction, vehicle traffic, and artificial lighting are activities that could disturb marine turtles or their nesting beaches (Raymond, 1984; Garber, 1985) and that would be of particular concern for Mississippi, Alabama, and Florida loggerhead turtle nesting areas. Vehicular and foot traffic have the potential to damage buried eggs and harm pre-emergent hatchlings. Artificial lighting on nesting beaches disrupts critical behaviors, including limiting nest site choice, nocturnal sea-finding behavior of both hatchlings and nesting females, and reduced nesting.

Sand mining, beach renourishment, and oil-spill cleanup operations may remove sand from the littoral zone and temporarily disturb onshore sand transport, potentially disturbing marine turtle nesting activities. Beach nourishment replaces rather than maintains original nesting habitat. Properties of artificially nourished beaches that differ from the natural beach include sorting, moisture content, reflection, and conduction. These properties affect the architecture of the egg chamber, incubation temperature, gas exchange, and water uptake, resulting in reduced egg and hatchling survivorship. The main causes of permanent nesting beach loss within the Gulf of Mexico are reduced sediment transport, a rapid rate of relative sea-level rise, coastal construction and development, and recreational use of accessible beaches near large population centers.

Chronic pollution, including industrial and agricultural wastes and urban runoff, threatens sea turtles worldwide (Frazier, 1980; Hutchinson and Simmonds, 1991) and may be a particular concern in coastal areas of Texas, Louisiana, and other Gulf States. Some turtle species have life spans greater than 50 years (Congdon, 1989), 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). Chronic pollution from industrial or agricultural sources is linked with immune suppression in some marine mammals and would similarly be a source of concern for marine turtles in the Gulf of Mexico.

Fibropapillomas, debilitating tumors occurring primarily in green turtles, also threaten sea turtles in populated coastal areas (Teas, 1991). Fibropapillomas may be accompanied by trematode and leech infestations and severe anemia (Norton et al., 1990). The disease was documented in the 1930's (Smith and Coates, 1938), but its incidence has increased in the last century, especially from 1985-1990, in Florida, Hawaii, and Puerto Rico turtles. The disease also appears to be increasing in other heavily populated coastal areas (Teas, 1991). The origin of marine turtle fibropapilloma disease is unknown, but viral and toxicological causes and immune suppression are among those under investigation (Jacobson, 1991). At present, the link between water quality degradation and health impacts on migratory marine vertebrates such as marine turtles is poorly understood, and no mortality estimates are available (NRC, 1990).

Structure installation and removal, pipeline placement, dredging, and water quality degradation may adversely affect marine turtle habitat through destruction of seagrass beds and live-bottom communities used by marine turtles. Wetlands and estuaries could be eroded along navigation channels in Louisiana and along the north Texas coast as a result of vessel traffic within the channels. The physical integrity, species diversity, and biological productivity of topographic features and live bottoms where marine turtles occur are expected to suffer only temporary damage or disturbance.

The OCS-related oil and gas service-vessel trips will occur across the entire Gulf during the 60-year analysis period for all OCS program activities (Table 4-6a). Collision between service vessels or barges and surfaced marine turtles would likely cause fatal injuries, but marine vessel operators can avoid marine turtles and reduce potential deaths. Between 1986 and 1993, about 9 percent of sea strandings identified by the U.S. sea turtle stranding network in the southeast United States and the Gulf of Mexico (Teas and Martinez, 1992; Teas, 1994) had propeller or other boat strike injuries. This mortality rate may grow if fishing, recreational, and oil- and gas-associated vessel traffic continue to increase.

Offshore operational discharges are not known to be lethal to marine turtles, and are diluted and dispersed within 1 km of the discharge point. Drilling fluids and cuttings and produced water will be discharged across the entire Gulf during the 60-year analysis period for all OCS Program activities (Table 4-6a). Unfavorable effects on marine turtle food sources by water quality degradation have not been previously demonstrated (American Petroleum Institute [API], 1989; NRC, 1983). Suspended particulate matter in offshore operational discharges and blowouts is expected to reduce visibility and may displace prey items in the vicinity. Marine turtles within 1 km of discharge points are less able to locate prey for the short time period they would spend traversing discharge plumes.

Explosive discharges such as those used for platform removals can cause capillary damage, disorientation, and loss of motor control in marine turtles (Duronslet et al., 1986). Although marine turtles far from the site may suffer only disorientation, those near detonation sites would likely sustain fatal injuries. The USDOI, MMS has issued mitigating guidelines for explosive platform removal to offshore operators to minimize the likelihood of removals occurring when marine turtles may be nearby, Table 4-6a presents estimates of structures that could be removed by explosives (about two thirds of all platform removals) across the entire Gulf as a result of all OCS Program activities during the 60-year analysis period. A few marine turtle deaths may occur as a result of oversights during the large number of projected removals. However, because of MMS guidelines and because marine turtles are widely distributed, and their densities would not be expected to be high near the vicinity of platform removals, the injury or mortality likelihood is low. It is expected that the incremental impact resulting from platform removals under the proposed action would be negligible.

Marine debris is a well-documented source of deaths and debilitation for marine turtles (NRC, 1990). Reports of debris ingestion exist for almost all sea turtle species and life stages. Pelagic sea turtles are most susceptible to debris ingestion because of their dependence on convergence zones where floating debris accumulates and the indiscriminate nature of their feeding strategy. High frequencies of debris ingestion have been reported for juvenile sea turtles in the northwestern Gulf of Mexico (Plotkin and Amos, 1990). Loggerheads and leatherbacks apparently ingest more debris than other sea turtle species. In addition to the trash and debris generated by the OCS Program and other users of the Gulf of Mexico, marine debris is carried into the Gulf and Atlantic via oceanic currents from South and Central America, Europe, and North Africa (Plotkin and Amos, 1988; Hutchinson and Simmonds, 1991). The volume of nonbiodegradable materials contributed by these sources is unknown. Turtles that consume or become entangled in debris may die or become debilitated (O'Hara, 1989; Heneman and the Center for Environmental Education, 1988). Plastics and other materials may remain in the gut for at least 6 months and may interfere with digestion, growth, and other physiological processes. Ingestion of plastic and styrofoam materials could result in drowning, lacerations, and reduced mobility, resulting in starvation (Carr, 1987; USDOC, NOAA, 1988b; Heneman and the Center for Environmental Education, 1988). The MMS prohibits the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458) prohibits the disposal of any plastics at sea or in coastal waters. Despite these safeguards, marine turtles can become entangled in or ingest trash and debris produced by human activity in the Gulf and elsewhere.

Noise from current and future Federal and State oil and gas activities (including helicopters, service and construction vessel traffic, seismic surveys, drilling rigs, and production platforms) would have the same kind of impacts as discussed for the proposed program (i.e., variable, transient, causing short-term behavioral changes, disruption of activities, departure from the area of disturbance). Vessel traffic as a source of transient noise is also associated with several of the non-OCS scenario activities, including dredging and marine disposal, extraction activities (nonenergy minerals, oil and gas from State waters), transportation (domestic and foreign tankers), and NASA/USDOD/USDOT operations. While many of these operations are continuous, vessel activity may or may not be intermittent. Incremental impacts to sea turtles from these additional seismic surveys under the OCS and non-OCS cumulative scenarios would be minor. The potential incremental impacts to sea turtles from routine drilling and production operations under the proposed action would be negligible. Therefore, incremental impacts from noise generated by OCS activities associated with the proposed program would be minor relative to those resulting from OCS and non-OCS cumulative activities.

Oil spills can adversely affect marine turtles by toxic external contact, toxic ingestion or blockage of the digestive tract, disruption of salt gland function, asphyxiation, entrapment, and displacement from preferred habitats (Witham, 1978; Vargo et al., 1986; Lutz and Lutcavage, 1989; Plotkin and Amos, 1988). When an oil spill occurs, the severity of effects and the extent of damage to marine turtles are affected by geographic location, oil type, oil dosage, impact area, oceanographic conditions, and meteorological conditions (NRC, 1985; USDOI, MMS, 1987b). In the past, tanker washings have been the main source of this oil (Van Vleet and Pauly, 1987). The number of large oil spills estimated to occur from Federal OCS activities in the Gulf and the probability of spill occurrence for the cumulative case are shown in Table 4-6c. Numerous large spills could occur in the Gulf of Mexico during the life of the proposal from foreign tankers transporting oil to Gulf Coast ports. Since marine turtle habitat in the Gulf includes both inshore and offshore areas, marine turtles are likely to encounter a few OCS or import tanker spills. Although marine turtles may encounter these spills in their inshore and offshore habitats, primarily sublethal and minor effects are expected in addition to some deaths that may occur. Sublethal biological and behavioral impacts could temporarily disturb oiled marine turtles. Few mortalities are expected because of the small area of contact involved, the rapid dispersion and loss of oil, and the low density of marine turtles in the area. The probability of these spills contacting the coast have not been estimated.

Oil-spill response activities, such as vehicular and vessel traffic in shallow areas of seagrass beds and live-bottom communities, can adversely affect marine turtle habitat and cause displacement from these preferred areas. As mandated by the Oil Pollution Act of 1990, 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 (see Appendix C).

As noted previously, spills from the OCS cumulative accident scenario would exceed the spills assumed for the proposed action. In addition, small and large spills may occur from non-OCS activities, many of which occur in nearshore coastal waters. Further, non-OCS spills are expected to far exceed OCS spills, including those assumed under the OCS cumulative accident scenario. The incremental impact of assumed oil spills under the proposed action would be variable, ranging from minor to moderate.

In summary, cumulative activities in the Gulf of Mexico have a potential to harm marine turtles. Those activities include structure installation, dredging, water quality and habitat degradation, operational discharges, blowouts, OCS-related trash and debris, vessel traffic, explosive platform removals, oil-spill response activities, oil spills, dredge-and-fill operations, natural catastrophes, pollution, hopper dredge operation, recreational boat traffic, and commercial fishing. Deaths resulting from OCS-related spills and import tankering, debris ingestion, or explosive platform removals are likely but should be few in number. The incremental contribution of the proposed action to the cumulative impact is expected to be negligible because most of the probable impacts (disturbances to feeding, disturbances to feeding habitat, and prey availability) are expected to be temporary. Marine turtles may avoid OCS Program activities and other disturbances by shifting their feeding and resting areas to undisturbed areas. Oil spills, oil-spill response activities, and explosive platform removals are potential threats that may cause marine turtle deaths, but the risks are greatly reduced by oil-spill contingency planning and by the MMS and biological opinion stipulations.

Conclusion: The cumulative impact of activities in the Gulf of Mexico on marine turtles would be **moderate** because they are expected to remove some animals from marine turtle populations and to temporarily displace marine turtles from feeding, reproduction, and resting habitats. The cumulative impact from all large oil spills, both OCS and non-OCS could be **minor to moderate** depending on the location and timing of the spills. The incremental impact of the proposed program to the overall cumulative impacts to sea turtles is considered **minor**.

4.8.2.8. Coastal Habitats

4.8.2.8.1. Barrier Beaches and Dunes

Sediment deprivation, poor sediment quality in coastal headlands, and rapid submergence have resulted in severe, rapid erosion of most of the barrier landforms along the Louisiana coast. The barrier island system of coastal Mississippi, Alabama, and Florida is well supported on a coastal barrier platform of sand. The Texas coast has experienced land loss due to a decrease in the volume of sediment delivered to the coast because of dams on rivers, and a natural decrease in sediment supply as a result of climatic changes during the past several thousand years. Beach stabilization projects (such as groins, jetties, and seawalls), as well as artificially maintained channels and jetties installed to stabilize navigation channels, are considered to accelerate coastal erosion. Various OCS-related activities such as the construction of pipeline and navigation canals have contributed to coastal losses. Because of improved techniques of bringing pipelines to shore in nondisturbing ways and the lack of new navigation canal construction, the contribution of the proposed action to the cumulative loss of beach environments along the Gulf Coast will be negligible.

Oil spills reaching shore and grounding on sandy beaches can have significant impacts depending on the method of cleanup used to remove the oiled sand. Areas undergoing high rates of coastal erosion from natural and non OCS-related causes can suffer short-term (up to 2-year) adjustments in beach profiles and configurations as a result of sand removal and disturbance during cleanup operations. The proposed action could contribute up to four spills in shallow waters (Table 4-1e) which could contact beaches and dune areas; however, this would be a small number when compared to the 47 spills which could result from tankers importing oil into the Gulf (Table 4-6c), some of which could reach coastal areas; and up to 20 OCS-related spills which could take place in shallow waters during the remaining producing years of the Gulf of Mexico oil and gas fields, resulting in moderate impacts. The contribution of oil-spill cleanup on beaches of this proposed program to the overall impacts to coastal sand dune environments and beaches is minor.

4.8.2.8.2. Wetlands

Wetlands loss along the Gulf Coast is well documented as it has been a major problem for some years. Development for agricultural, residential, and commercial uses has affected coastal wetlands. In addition, subsidence of the Gulf Coast has flooded many wetlands areas and replaced marsh with open water, and the building of canals for navigation, trapping, and onshore oil and gas exploitation added to the situation. Current oil and gas activity contributes to wetlands loss mainly through maintenance of navigation channels to shore bases. As many as four new shore bases could result from the proposed action, but these will not be constructed in wetland areas. Also, no new onshore processing facilities are required to process the resources developed as a result of the adoption of the proposed action. The contribution of this proposed program to Gulf of Mexico wetlands loss will be minor.

Wetland and seagrass contacts by large oil spills can occur from a number of sources. Large oil spills could occur in shallow water, and some of this oil could make contact with the coast. Should the oil come into contact with a stretch of wetlands not protected by a coastal barrier island, or should the spill occur in coastal waters, wetlands or seagrass beds may be contacted and affected, resulting in moderate impacts. The amount of wetlands loss due to contact with oil spilled from OCS-related operations is expected to contribute only a small amount of the total loss of wetlands, with subsidence, erosion, and reduced sediment input from streams continuing to be major factors. The contribution of the proposed action to cumulative wetlands loss should be minor.

Conclusion: The overall cumulative impact to beaches, dunes, and wetlands from routine oil and gas activities and non-OCS-related causes is expected to be **minor.** The overall impact, if large oil spills were to occur and contact these resources, could be **moderate.** The 2002 OCS Program contribution to those impacts is expected to be **minor.**

4.8.2.9. Seafloor Habitats

4.8.2.9.1. Topographic Features

A Topographic Features Stipulation has been in effect for specific lease blocks near these features since 1973, as discussed in Section 4.3.2.9.1. The cumulative impacts to these features resulting from OCS activities, including those that may occur as a result of the proposed action, have been greatly reduced or eliminated by this stipulation and by the establishment of No Activity Zones. Physical impacts to the features by platform placement and removal, pipeline construction, and OCS-related vessel anchoring should not occur. Compliance with this stipulation suggests that the incremental impact from the proposed action to the OCS scenario would be negligible.

The volumes of drilling muds and cuttings expected from the OCS cumulative scenario are presented in Table 4-6a. While the more toxic oil-based drilling muds cannot be discharged under the conditions of the USEPA's National Pollutant Discharge Elimination System (NPDES) permit, there is potential for enrichment of some contaminants in sediments exposed to discharges of water-based muds, especially for discharges in water depths of less than 400 m. If drilling effluents were discharged at the surface in close proximity to a topographic feature, they could impact bank biota; however, the Topographic Features Stipulation precludes these activities in No Activity Zones and requires shunting of these discharges in the zones around the banks. This would limit the potential impacts from drilling effluents to bank biota.

Produced waters have the potential to impact the biota of the topographic features. Produced water discharges from the OCS cumulative scenario are detailed in Table 4-6a. The Topographic Features Stipulation described previously would also prevent the discharges of effluents within No Activity Zones, almost totally eliminating the potential for drilling muds, cuttings, and produced waters to reach and impact the biota of the banks. As a result of the implementation of the Topographic Features Stipulation and No Activity Zones, the proposed action and OCS cumulative activity impacts to the topographic features would be negligible.

Non-OCS activities could include anchoring, fishing/trawling, offshore marine transportation, diving, and the tankering of imported oil. Anchoring of non-OCS activity vessels on these features could cause significant damage to the hard bottom fauna. This activity could involve recreational and commercial fishing boats, scuba divers, and commercial ship traffic. The amount of damage would depend upon vessel size, the size of the anchor and chain, sea conditions at the time of anchoring, and the location or position of the anchor on the feature. Areas damaged by anchors could take more than 10 years to recover, depending upon severity. Due to a lack of regulation of non-OCS activities on these features, there is a likelihood of damages increasing due to heavier usage of the resources. Fishing activities could cause a depletion in fish abundance at various features, depending upon fishing intensity. Scuba divers could also cause a slight depletion in resources due to collecting activities. None of these activities, however, are likely to have a significant impact on the biota of the Flower Garden Banks which are designated as a national marine sanctuary. Anchoring and diver collection activities on the living reef areas of the sanctuary are prohibited.

Impacts could occur due to discharges from other non-OCS activities, including tankers or other marine traffic passing in the vicinity of the banks. It is expected that, due to water depths of greater than 20 m at the tops of most of the banks, and the dilution factor, discharges would not be concentrated enough to impact the bank communities.

Impacts from hurricanes and winter storm events can also affect the corals on some of the shallowest banks. Corals could be dislodged or toppled, and storm waves could cause sand abrasion to the living coral tissues.

Of the oil spills assumed to occur in the cumulative action scenario, only the 4,600-bbl pipeline spills in deep water in the Central and Western Gulf of Mexico Planning Areas could affect topographic features. Other assumed large spills are either at the surface or in shallow water. Oil from surface spills can penetrate the water column to documented depths of 20 m; however, at these depths, it would be at concentrations several orders of magnitude lower than those demonstrated to have an effect on marine organisms. Due to the water depths of the topographic features, it is unlikely that any significant amounts of oil from surface spills would reach the sensitive communities.

Oil spills from pipeline ruptures or blowouts would be more likely to impact the topographic feature communities, as discussed in Section 4.3.2.9.1. While subsurface oils spills are unlikely to be lethal to corals and most other bank biota, chronic toxicity to corals and acute toxicity to embryos and fish and invertebrate larvae could occur as a result of cumulative spills. The use of dispersants on oil spills in the vicinity of the topographic features could cause these compounds to reach the deeper water reef areas; however, studies indicate the effect of chemically dispersed oil on corals is no different from the effect of oil alone, as noted in Section 4.3.2.9.1.

It is possible that oil spills from outside the No Activity Zones could reach the vicinity of the topographic features. However, because of the depth of the banks, the bank biota would probably not be affected by the subsurface oil. With the crests of all the banks being at least 15 m below the surface, the concentrations of any oil driven to at least this depth would be far below that capable of causing an impact. Subsurface oil spills would have to come into contact with a bank feature almost immediately to have any detrimental impact, due to the rapid dilution of the spill. Because the topographic features are distributed over a wide area of the shelf edge, the likelihood of any one subsurface spill reaching more than one feature would be minimal. Furthermore, water currents moving around the banks would carry the spill components around the banks rather than directly over the features, lessening the severity of the impact (Rezak et al., 1983).

The incremental impacts of oil spills assumed under the cumulative action to the topographic features or bank communities would be minor. The Topographic Features Stipulation described above would prevent drilling in the No Activity Zones, preventing most of the adverse effects from platform-associated oil spills. Oil spills outside the No Activity Zones should not impact sensitive bank biota due to the distance from the spill to the bank. If impacts to the bank were to occur, in most cases the effects to sensitive biota would be sublethal, with recovery occurring within a 2-year period. In the extremely unlikely event that oil from a subsurface spill were to reach a coral reef community (e.g. Flower Garden Banks) in lethal concentrations, a limited area would be impacted, but recovery could take up to 10 to 20 years.

Conclusion: As a result of the implementation of the Topographic Features Stipulation and No Activity Zones, cumulative impacts from OCS activities to the topographic features would be **negligible**. If a large oil spill were to contact a topographic feature, the impact would be **minor**. The incremental impacts of routine activities assumed under the proposed action would be **negligible,** and impacts if large oil spills from the proposed action were to contact topographic features would be **minor**.

4.8.2.9.2. Live Bottoms and Pinnacle Trend

Live bottom areas of concern are found in the north-central to eastern Gulf of Mexico off Mississippi, Alabama, and Florida, from the inner shelf out to the shelf break. Impacts to these areas were discussed in Section 4.3.2.9.2.

Due to the sensitive nature of live bottom communities, specific lease stipulations have been instituted for blocks in both the eastern and central Gulf, as described in detail in Section 4.3.2.9.2. The cumulative analysis for live bottom habitat includes potential impacts under the proposed program plus those related to OCS and non-OCS activities. The OCS-related factors could include platform placement and removal, pipeline construction, platform discharges, and anchoring. Non-OCS activities having the potential to impact live bottom communities include commercial and recreational fishing, boating, tanker and shipping operations, and natural events.

The installation of drilling rigs or production platforms on the seafloor and associated anchoring activities would crush any organisms under the legs supporting the structure. Total area affected by rig or platform placement assumed under the OCS cumulative scenario is detailed in Table 4-6a. Live Bottom Stipulations were established to prevent oil and gas activities in the immediate area of live bottom or hard bottom communities. Adherence to these stipulations should prevent physical disturbances from platforms and anchoring to these communities.

Pipeline placement and removal could impact live bottom communities through resuspension of sediments and actual burial of organisms, as discussed in Section 4.3.2.9.2. The pipeline and support ship anchoring activities could also cause physical damage to the hard-bottom structure in live bottom communities. Total area affected by pipeline installation under the OCS cumulative scenario is noted in Table 4-6a for the eastern and central Gulf. Live Bottom Stipulations should prevent the direct physical disturbance of the live bottom communities by activities under the OCS cumulative scenario, including pipeline placement, limiting impacts to the resuspension of sediments. The majority of the pipelines are situated in the central Gulf, where existing live bottom communities have evolved under conditions of periodic relatively high near-bottom turbidity. The resuspension of sediments during pipeline operations would be of a short duration and should have minimal impacts on live bottom communities.

Explosive and nonexplosive removal of structures disturbs the seafloor and could potentially impact nearby live bottom communities through resuspension of sediments, as noted in Section 4.3.2.9.2. Given the number of platform removals expected under the OCS cumulative scenario (Table 4-6a), impacts to hard bottom areas by the explosive removals are not expected to be significant, primarily because the Live Bottom Stipulation would keep the platforms away from live bottom communities and due to the limited duration and area of actual impact associated with sediment resuspension.

The discharge of drilling muds and cuttings could cause increased turbidity and localized deposition of sediments on the seafloor, as discussed in Section 4.3.2.9.2. Volumes of discharged drilling muds and cuttings under the OCS cumulative scenario are presented in Table 4-6a. Overall, impacts to live bottom communities by cumulative drilling mud and cuttings discharges should be low due to the Live Bottom Stipulation preventing oil and gas activities in the immediate vicinity of live bottom or hard-bottom communities.

Volumes of produced water released per month in the central and eastern Gulf under the OCS cumulative scenario are detailed in Table 4-6a. Produced waters could impact the biota of pinnacles and hard bottom features due to sediment contamination with moderate amounts of petroleum hydrocarbons and metals, as described in Section 4.3.2.9.2. This should be minimized by limitations in the NPDES permits as well as by the Live Bottom Stipulations, which would prevent the placement of oil and gas platforms in the immediate vicinity of live bottom areas or pinnacle features. The depth of the pinnacle features and live bottom areas, prevailing current speeds, and offsets of the discharges from the live bottom areas would also cause the produced waters to be diluted prior to coming into contact with sensitive biological communities. As a result, these cumulative discharges should not have significant impacts on the live bottom communities.

Non-OCS activities also have a limited potential to impact live bottom communities. While most of the non-OCS activities listed previously (see Section 4.8.1.2) are unlikely to affect live bottom communities, several activities may produce impacts when considered in a cumulative context. Both recreational and commercial fishermen utilize live bottom areas for fishing, and anchor in these areas. Anchor damage to the bottom can be significant in easily accessible and popular locations. Although the pinnacles' hard bottom areas are further from shore, they are used for anchoring by larger commercial and recreational boats. Various size anchors, 5- to 10-lb fishing weights, and yards of heavy fishing line have commonly been observed during ROV surveys of pinnacle features during MMS-funded studies (Brooks, 1991; Continental Shelf Associates, Inc., 1992b; Continental Shelf Associates, Inc. and Texas A&M University, Geochemical and Environmental Research Group, 2001). Many of these live bottom and pinnacle areas are also along major shipping routes or fairways and could be subject to anchor damage from freighters on occasion.

Natural events, including hurricanes, turbidity plumes, and hypoxia could also impact these features, although they should certainly be adapted to these events. A severe event could cause localized damage and impact species diversity and productivity for a short period of time.

The incremental impact of the proposed action to the pinnacles and live bottom communities in the central and eastern Gulf, relative to impacts from the OCS cumulative scenario, should range from negligible to minor. Implementation of the Live Bottom Stipulations would prevent the occurrence of any physical damage to the features. Impacts from resuspension of sediments would also be low due to the brief period of occurrence relative to activities and the relocation of oil and gas activities away from specific live bottom or pinnacle features. Impacts to live bottom communities as a whole are expected to be negligible, with no community-wide impacts likely. Non-OCS impacts from fishing, anchoring, and natural events should be localized in nature and also range from negligible to minor, with no community-wide impacts occurring.

Potential oil spills assumed under the cumulative scenario are tabulated in Table 4-6c. Oil from surface spills can penetrate the water column to documented depths of 20 m, but at these depths, it would be at concentrations several orders of magnitude lower than those demonstrated to have an effect on marine organisms. Due to the water depths of the pinnacles features and live bottom communities, it is unlikely that any significant amounts of oil from surface spills would reach the sensitive communities. Oil spills from pipeline ruptures would be more likely to impact the live bottom communities, as discussed in Section 4.3.2.9.2. If a large subsurface pipeline spill were to occur near a pinnacle or live bottom area, the biota could be impacted, with lethal effects occurring in localized areas. The Live Bottom Stipulations (both low relief and pinnacle trend) described above should prevent drilling activities in the immediate vicinity of pinnacles and live bottom communities, preventing most of the adverse effects from platform-associated oil spills. If impacts to the live bottom communities were to occur from oil spills or from pipeline ruptures, in most cases the effects to sensitive biota would be sublethal, with recovery occurring within a 2-year period. The incremental impact of accidents under the proposed action to pinnacles and live bottom communities, relative to impacts from OCS cumulative activities, would be minor.

Conclusion: Overall cumulative impacts to the live bottom and pinnacle trend communities in the central and eastern Gulf from OCS and non-OCS activities and oil spills would be **minor**. The incremental impacts due to routine activities of the proposed action to the pinnacles and live bottom communities could range from **negligible** to **minor**. The incremental impact, if large oil spills from the proposed action were to contact pinnacles and live bottom communities, would be **minor**.

4.8.2.9.3. Submerged Seagrass Beds

Cumulative impacts to submerged seagrass beds may result from the coastal development associated with OCS exploration and development. The largest seagrass beds are in the Eastern Gulf of Mexico Planning Area, where no coastal development is assumed. The potential for cumulative impacts to seagrass beds from OCS and non-OCS cumulative activities, and the incremental impacts from the proposed action, are the same as those described previously for wetlands. Whether or not these potential impacts occur is dependent upon the specifics of individual coastal development projects as they are built. The incremental increases in impact from the proposed action would be minor.

As noted previously in the discussion of accident impacts on wetlands, oil spills reaching shore may have moderate impacts on coastal communities. Cumulative oil spills in shallow water in the Gulf of Mexico from OCS and non-OCS activities could have significant impacts in these coastal communities. Based on the accident scenario under the proposed action (see Table 4-1a), the incremental increases to the OCS cumulative scenario would be most significant in the central and eastern Gulf. Impacts to submerged seagrass communities in the eastern Gulf have the potential to be of major significance due to the extensive growth of seagrasses along that coastline. Incremental increases in oil spill impacts would be minor to moderate.

Conclusion: The cumulative impacts to seagrass beds from routine activities would be **minor.** If large oil spills were to occur and contact submerged seagrass communities in the eastern Gulf, impacts could be **major** due to the extensive growth of seagrasses along that coastline. Incremental increases in oil spill impacts would be **minor to moderate**.

4.8.2.9.4. Chemosynthetic (Seep) Communities

Communities which, because of their limited occurrence in the Gulf of Mexico, could be potentially impacted under the OCS cumulative scenario include the chemosynthetic or seep communities. Most of the chemosynthetic communities are low diversity and spread throughout the deeper areas of the Gulf of Mexico, although high density communities may be found associated with high concentrations of seeping hydrocarbons, as described in Section 3.1.2.7.5.

Cumulative impact factors for chemosynthetic communities include both OCS and non-OCS activities. Impact producing factors from OCS routine operations that could potentially have an effect on chemosynthetic and seep communities include bottom-disturbing activities associated with rig or platform placement and removal, flowline/pipeline installation and removal, anchoring, and discharges of drilling muds and cuttings. These activities have been discussed in Section 4.3.2.9.4.

Mitigation measures instituted to protect these high-density chemosynthetic communities include Notice to Lessees and Operators 2000-G20, which makes mandatory the avoidance of chemosynthetic communities or areas that have a high potential for supporting these community types, as interpreted from geophysical records (see Section 4.3.2.9.4). These requirements are believed to be effective in identifying areas of chemosynthetic communities, but it may still be possible that some chemosynthetic communities would not be distinguished by these procedures.

The incremental increase in activity of the proposed action to the OCS cumulative scenario is likely to cause little damage to the more widespread, low-density chemosynthetic communities, and the level of impact would be minor. If any impacts were to occur, the community would recover over time. The high-density Bush Hill-type chemosynthetic communities would be more sensitive to physical disturbance damages, and recovery times could be extensive for these communities. The impact category would be minor if avoidance mitigation were applied, but if these types of communities were not detected and were physically disturbed, the impact could be classified as moderate. In this case, the affected resource may not recover completely, but the viability of the resource as a whole would not be threatened.

Non-OCS activities that have the potential to adversely affect chemosynthetic communities include fishing/trawling, anchoring, dredging and ocean dredged material disposal, offshore marine transportation, and USDOD operations. However, due to the water depths of these areas, these activities are unlikely to impact the chemosynthetic communities of the Gulf.

Potential oil spills for both the OCS cumulative scenario and proposed action contributions have been described previously in this section and in Table 4-6c. Although petroleum hydrocarbons serve as a nutrient source for symbiotic microorganisms associated with macrofaunal species comprising the chemosynthetic, large oil spills occurring on the seafloor could have adverse impacts on these communities. The communities are assumed to recover without mitigation and the level of cumulative impact would be minor to moderate.

Conclusion: Cumulative impacts to chemosynthetic communities expected from routine activities would be **minor** to **moderate**. Cumulative impacts, if large oil spills were to occur on the seafloor, would be **minor** to **moderate**. The incremental increases in impact under the proposed action would be **minor.**

4.8.2.9.5. Other Benthic Communities

Cumulative impact factors for continental shelf, slope, and deep-sea soft-bottom communities include both OCS and non-OCS cumulative activities. The OCS activities include bottom-disturbing activities associated with rig or platform emplacement and removal, flowline and/or pipeline installation and removal, anchoring, discharges of drilling mud and cuttings, and discharges of produced waters (Table 4-6a). Non-OCS factors could include fishing/trawling, anchoring, dredging and ocean dredged material disposal, nearshore and offshore marine transportation, and hurricanes.

Types of impacts due to rig placement, platform installation and removal activities, pipeline placement and removal, and the discharge of drilling muds, cuttings, and produced water have been discussed in Section 4.3.2.9.5. The estimated numbers of platforms and bottom area disturbed by platform placement and pipeline installation under the OCS cumulative scenario are presented in Table 4-6a. The maximum area of seafloor in the entire Gulf of Mexico (including the continental shelf, slope, and deep-sea habitats) that would be directly impacted from platform placement and pipeline installation under the OCS cumulative scenario would be approximately 20,280 hectares (ha) out of an estimated area of more than 80 million ha.

Dredging operations in conjunction with ship channel maintenance and construction, pipeline placement and burial, and support facility access occur throughout the Gulf of Mexico. Sediments dredged and sidecast or transported to approved dredged material disposal sites could cause smothering and some mortality of sessile animals in the vicinity of the activity. Impacts from these operations were detailed in Section 4.3.2.9.5.

Sulfur mines in the vicinity of the Mississippi River Delta remove sulfur from the cap rock over salt domes, which can cause localized seafloor subsidence. This could impact oil platforms and pipelines within the immediate area.

Oil and gas exploration and production activities in Gulf of Mexico State waters occur primarily off Louisiana, Texas, and Alabama in the vicinity of Mobile Bay. The States of Florida and Mississippi have had limited activities in State waters, with a moratorium on drilling activity now in effect in Florida waters. Impacts of drilling operations in State waters to benthic communities of the shelf would be similar to those identified in Section 4.3.2.9.5.

Other non-OCS activities, including fishing/trawling, diving, anchoring, nearshore and offshore marine transportation, deepwater ports, USDOD activities, and hurricanes, would have minimal impacts on Gulf of Mexico soft-bottom habitats.

The predominant seafloor habitat on the Gulf of Mexico continental shelf, slope, and deep sea consists of muddy to sandy sediments, as discussed in Section 4.3.2.9.5. Incremental impacts to other benthic communities under the proposed action (relative to impacts from cumulative OCS and non-OCS activities) would be minor.

Oil spills assumed under the OCS cumulative scenario have been detailed in Table 4-6c. As noted, large oil spills could occur from tanker spills in deep water, from platform spills in both shallow and deep water, from pipeline spills in both shallow and deep water, and from production facility spills in deep water. Additionally, there could also be numerous small spills of 1 to 999 bbl of oil (Table 4-6c). Oil from surface spills would not affect other benthic communities, as discussed previously. Oil spills from pipeline ruptures or blowouts would be more likely to impact soft-bottom benthic communities, although the low molecular weight hydrocarbons should be released into the atmosphere within several days after the spill without any significant biological effect, as discussed in Section 4.3.2.9.5. The impact level of oil spills under the cumulative scenario to soft-bottom benthic communities of the continental shelf would be minor.

Conclusion: Cumulative impacts of routine activities on other soft-bottom benthic communities in the Gulf of Mexico would be **minor**. The impact level, if large oil spills were to contact soft-bottom benthic communities, would be **minor**. Incremental impacts to other benthic communities in the Gulf of Mexico from the proposed action would be **minor**.

4.8.2.10. Areas of Special Concern

4.8.2.10.1. Essential Fish Habitat

Cumulative OCS activities that may affect essential fish habitat (EFH) in the Gulf of Mexico include increased bottom area disturbed by the installation of new platforms and pipelines (Table 4-6a). Increases in the deposition of drilling fluids and cuttings will increase turbidity in the water column. This will have an impact on EFH which includes those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity. The quality of the water under EFH includes its chemical properties. Increased turbidity changes the chemistry of the water and reduces the quality. Platform removals using explosives, the majority occurring in the Central Gulf of Mexico Planning Area, will kill many fish, including managed species for which EFH has been established. Most turbidity in the water column from the dumping of drilling fluids and cuttings will ultimately settle out, and only some of the benthic EFH habitat will be changed so that benthic prey of managed fish species cannot recolonize. However, the potential to kill large populations of fish as the result of removal of platforms by explosives could have food web effects on both the managed species and their prey species.

There are also State oil and gas activities that can affect EFH. Both Louisiana and Texas have experienced significant oil and gas development within their coastal areas including exploratory drilling, production platform installation, and pipeline installation. Impacts to EFH from these activities would be similar and possibly more severe than those effects from routine OCS activities. Because the activities are closer to shore and in more shallow environments, more benthic EFH may be damaged, and the effects of sedimentation and water column turbidity may be observed throughout more of the water column.

Non-OCS activities that influence EFH may include commercial fishing, commercial shipping (tanker transportation), land development, water quality degradation, dredge and fill and dredge disposal operations, and marine mining (other nonoil and gas extraction minerals). Additionally, excavation and maintenance of channels, construction and operation of ports, moorings, cargo handling facilities, construction and operation of ship repair facilities, and construction of channel stabilization structures such as jetties will impact EFH (GMFMC, 1998).

There is one deepwater port (Louisiana Offshore Oil Port) in the Gulf of Mexico which is located in Grand Isle Block 59, approximately 19 miles from shore. A concentration of vessel traffic in this area requires various fixed and mobile structures for anchoring. Fixed structures will reduce some benthic EFH and provide substrate for sessile organisms.

Barges carrying cargo arrive and depart through ports and travel through the Gulf Intracoastal Water Way, which serves as a major route for needed goods and supplies. Discharges of treated wastes and other discharges of hazardous chemicals have negative impacts on water quality, a component of EFH, as well as aquatic vegetation.

Pollutants generated from boat maintenance activities on land and water negatively impact water quality. These include a variety of boat cleaners, such as teak cleaners, fiberglass polish, and detergents (USEPA, 1993). Oil and grease are commonly found in bilge water, especially in vessels with inboard engines, and these products may be discharged during vessel pump out (USEPA, 1993).

Routine dredging operations for channel construction and maintenance, pipeline emplacement, and creation of harbor and docking areas will increase turbidity and change the chemistry of the water within the water column. This will negatively impact water quality and, consequently, EFH. Sedimentation which will result in changes to the physical properties of EFH will smother the benthic prey of some managed fish species. Ultimately, the benthic EFH would recolonize unless maintenance dredging operations were repeated frequently.

The 35 operational ocean dumping sites in the Gulf of Mexico, most of which are located within State waters also have an impact on water quality as EFH and benthic EFH for those managed fish species that use the benthos as part of their habitat or consume benthic prey. Sixteen of the 35 ocean disposal sites are located mostly within State waters in the Western Gulf of Mexico Planning Area. Nine are in the Central Gulf of Mexico Planning Area, and 10 are in the Eastern Gulf of Mexico Planning Area. Depending on the ocean dumping sites proximity to shore, the Western Gulf of Mexico Planning Area has the greatest potential to experience the smothering of submerged seagrasses since over 98.5 percent of the Gulf of Mexico coastal seagrasses are located off the Texas coast.

Among the Gulf of Mexico States, coastal Louisiana experiences the highest wetland losses (13,000 ha/year) (USDOI, MMS, 2000). This may be caused by several factors including fluid withdrawals from oil and gas reservoirs, erosion, and human-induced subsidence from groundwater withdrawals. Loss of wetland habitat is a loss of important EFH for many larval and juvenile stages of managed species.

Commercial and recreational fisheries in the Gulf of Mexico also impact on EFH. Most of the wild caught shrimp are harvested using bottom trawls. The nets are held open with bottom sled devices made from wood or steel. This is a nonselective harvesting method, and the sleds or "doors" drag along the bottom sediments collecting shrimp and by-catch, and potentially digging up sediments and hard substrate (Gaston, 1990). Trawls pulled over the bottom disrupt the benthic community, eliminating organisms on the sediment surface and increasing the turbidity of the water (USEPA, 1994d).

Spiny lobster and stone crab traps may also damage bottom substrate such as seagrasses and corals. Strings of unbuoyed traps are sometimes retrieved by dragging 40-pound grapnels and chains across the bottom until the trap string is hooked, in the process adversely affecting the bottom community.

The cumulative effects of oil spills from OCS and non-OCS activities (Table 4.6c) may affect several relevant resources that directly affect EFH, including surficial sediments, water quality, fish resources, coastal habitats, and seafloor habitats and benthic communities.

Surface oil from shallow-water spills will impact surface water EFH. Many managed fish species use surface waters as part of their life cycle. Those that spawn in surface waters deposit pelagic eggs, many of which grow into pelagic larvae and move by means of surface currents. Unlike adult fish that can move away from oiled waters, pelagic eggs and larvae that come into contact with surface oil will not be able to move away and will be injured or killed possibly through smothering or accumulation of oil on the gills of juvenile fish. The oiled surface waters temporarily reduce the amount of suitable available EFH for these life stages.

Habitat Areas of Particular Concern (HAPC's) include intertidal and estuarine habitats with emergent and submerged vegetation, sand and mud flats, and shell and oyster reefs that may provide food and rearing for managed juvenile fish and shellfish. Shallow-water spills may reach these coastal EFH areas and have negative impacts. Emergent aquatic vegetation, which is often habitat for sessile prey of managed species, will become coated with oil, and these sessile organisms will be unable to flee and will be killed. These areas represent important nursery areas for fishes and invertebrates that contribute to estuarine, coastal, and shelf food webs. Surface spills will temporarily diminish surface water EFH areas used by the eggs, larvae, and some prey species of managed fish species.

Seagrasses and macroalgae that provide nursery grounds for many fish species and habitat for many larval and adult invertebrates critical to nearshore food chains may also become oil coated and ultimately smothered (USDOI, MMS, 1983a). Abrasive cleanup techniques may also damage, destroy, or remove coastal EFH.

Grand Bay, Mississippi, located in southeast Jackson County, is an example of an HAPC that may become oiled in a shallow-water spill in either the Central or Eastern Gulf of Mexico Planning Area.

Shallow-water wave action may increase entrainment of oil and tar balls in the water column. Tar balls may reach benthic EFH. This would temporarily diminish the quality and quantity of benthic EFH. Settled tar balls may be ingested by bottom feeding fishes and may harm or prove fatal to them.

The deepwater pipeline spill and tanker spill in the Western Gulf of Mexico Planning Area (Table 4-6c) could impact HAPC offshore areas with substrate of high habitat value and diversity or vertical relief such as those that may be found in the Flower Garden Banks National Marine Sanctuary. A surface spill could destroy not only managed fish eggs and larvae but pelagic coral eggs. Corals spawn usually over a period of a few days. This minimizes the opportunity for a spill to come into contact with these pelagic larvae. However, if a spill were to come into contact with these pelagic larvae, it could have a major impact on that year class of corals.

Cumulative deepwater spills in the Central Gulf of Mexico Planning Area greatly increase the probability that surface water EFH for many managed species will be affected. Many of these species spawn in surface waters; their eggs, larvae, and invertebrate prey species are pelagic. If the eggs and larvae were concentrated due to wind and water currents, large numbers of these organisms would be injured or killed.

Spills from import tankers (Table 4-6c) can occur offshore in shipping lanes or in coastal waters as the tankers prepare to make landfall. The actual locations of the spills will determine where the increased damage to EFH will take place.

Conclusions: Cumulative effects on EFH from both OCS and non-OCS routine activities would be most severe in the coastal, inshore low-energy environment and in the benthic environment. Impacts would range from **minor** to **moderate**. Cumulative effects from oil spills on EFH may range from **minor** to **moderate** depending on the time of year, wave and other weather conditions, and the amount of oil that reached the coastal area, especially in seagrass beds and other aquatic vegetation. Effects from the 2002 OCS Program activities would be **minor**.

4.8.2.10.2. National Marine Sanctuaries

Two national marine sanctuaries have been established in the Gulf of Mexico–the Flower Garden Banks National Marine Sanctuary and the Florida Keys National Marine Sanctuary, as discussed in Section 3.1.2.8.2. The Flower Garden Banks National Marine Sanctuary is protected from potential damage due to oil and gas exploration and development by an MMS Topographic Features Stipulation, which includes a "No Activity Zone." Both sanctuaries are also protected by regulations (15 CFR 922) that prohibit various activities. The prohibited activities generally include: exploring for, developing, or producing minerals or hydrocarbons; removing, injuring, or possessing live rock; discharging or depositing materials; operating vessels in a manner that would strike or injure immobile organisms attached to the seabed; anchoring; taking or possessing any marine mammal, turtle, or seabird; and possessing or using explosives or electrical charges within the sanctuary boundaries.

The cumulative impacts to features within the Flower Garden Banks National Marine Sanctuary have been greatly reduced by these regulations, which prevent any physical impacts to the sanctuary due to platform placement and removal, pipeline construction, and OCS-related vessel anchoring. Additional OCS cumulative impact factors include discharges of drilling cuttings, drilling muds, and produced waters. The estimated volumes of drilling fluids, cuttings, and produced waters under the proposed action and the OCS cumulative scenario are presented in Tables 4-1e and 4-6c. Impacts resulting from these discharges (from both the proposed action and OCS cumulative activities) would be almost totally eliminated due to no discharges being allowed within the No Activity Zone and the requirement that discharges be shunted to within 10 m of the bottom within the 4-mile zone.

Non-OCS activities include fishing, diving, offshore marine transportation, and tankering. Natural events such as hurricanes can also impact the sanctuaries. Fishing and diving impacts are expected to be minimal due to the establishment of sanctuary guidelines regulating these activities and the distance of the sanctuary from shore. The sanctuary regulations also prohibit collecting activities within the sanctuary. In addition, the ban on anchoring within the sanctuary would prevent or minimize a major source of structural damage to the reef system, which has been caused by both commercial vessels and recreational boaters.

Impacts to the Florida Keys National Marine Sanctuary could occur due to discharges from tankers or other marine traffic passing in the vicinity of the sanctuary. Due to water depths within the sanctuary being greater than 20 m and the dilution factors associated with discharges, no cumulative impacts to the coral communities are expected.

Hurricanes and winter storms could also impact corals at the shallowest depths in the sanctuary, due to toppling of the corals and abrasion by sand. Due to the unpredictable nature and strengths of hurricanes and storms, they could cause the most severe impact to the sanctuary resources, although recovery would occur.

Oil spills could occur from tanker spills in deep water, from platform spills in shallow water, from pipeline spills in both shallow and deep water, and from production facility spills in deep water. Oil from surface spills can penetrate the water column to depths of 20 m; however, concentrations of hydrocarbons at these depths are several orders of magnitude lower than those demonstrated to affect marine organisms. Due to the depths of the coral communities at the Flower Garden Banks, it is unlikely that significant amounts of oil from cumulative surface spills would reach these communities. Oil spills from pipeline ruptures or blowouts would be more likely to impact the Flower Garden Banks communities. If oil from a series of subsurface spills were to reach one of these bank communities, impacts to the sensitive biota could be significant. Potential impacts have been discussed in Section 4.3.2.10.2. Any cumulative impacts associated with spills reaching sensitive biota would most likely be sublethal, with recovery occurring within an estimated 2 years.

The Topographic Features Stipulation, with the additional regulations described above, would preclude drilling in the No Activity Zones, preventing most of the adverse effects from platform-associated oil spills. Oil spills outside the No Activity Zones should not impact sensitive bank biota due to the distance from the spill to the bank. If impacts to the bank were to occur, in most cases the effects to sensitive biota would be sublethal, with recovery occurring within a 2-year period. In the unlikely event that oil from a subsurface spill were to reach the coral reef community in lethal concentrations, a limited area would be impacted, and recovery should occur within 10-20 years. If oil spills were to contact the Flower Garden Banks communities, impacts would be minor.

There are no OCS leasing activities assumed for areas in the vicinity of the Florida Keys National Marine Sanctuary; the nearest areas offered for lease are located more than 500 km to the northwest of the sanctuary. This would prevent spills from either platforms or pipelines reaching the sensitive reef communities of the sanctuary. A more likely source of oil-spill impacts would be from a non-OCS activity—a tanker running aground in the shallow waters of the Florida Keys. The impact level of all oil spills to the Florida Keys National Marine Sanctuary under the cumulative scenario would be minor. The incremental impact of oil spills under the proposed action (compared to the OCS cumulative accident scenario) would be negligible.

Conclusion: The overall cumulative impact to national marine sanctuaries from all activities and natural events is expected to be **minor**. If an oil spill were to contact the sanctuaries, impacts could be **minor**. As a result of lease stipulations and sanctuary regulations currently in place, the incremental impacts of the 2002 OCS Program should be **negligible**.

4.8.2.11. Population, Employment, and Regional Income

As is evident in Table 4-9, yearly employment related to OCS activity adds between 0.1 and 0.3 percent to the total economy of the Gulf Coast region. Most of this activity is concentrated in the Central Gulf of Mexico Planning Area, where offshore oil and gas work adds between 7,000 and 24,000 additional jobs. These jobs are projected to generate a minimum of $279 million (1987 constant dollars) beginning in 2005 and may well increase to maximum yearly levels of $929 million by 2010. This employment and earning supports, directly and indirectly, up to 46,000 persons in onshore areas adjacent to this planning area.

Between 2,100 and 8,700 jobs accrue to the Western Gulf of Mexico Planning Area. The additional employment represents .05 to .2 percent of the region's total. This employment translates to between $80 million and $333 million in yearly earnings. The Eastern Gulf of Mexico Planning Area has the lowest level of total OCS activity under the proposed action, adding from $12 million to $64 million in earnings for some 300 to 1,700 additional jobs (between .01 and .03 percent of the regional total).
Employment impacts of oil spills reaching landfall can vary considerably depending upon the total volume of oil reaching land, land area affected, and sensitivity of local environmental conditions to oil impacts. Overall, however, there are two categories of industries that are most sensitive to the direct effects of landfall oil spills–primary resource extraction (excluding oil and mining activities) and tourism, as discussed in detail in Section 4.8.2.14. Perceived aesthetics and recreational opportunities of the coastal environment are also important considerations. Oil spills reaching land can have both short- and long-term effects on these recreational coastal activities. The coastal labor market areas throughout the Gulf of Mexico are projected to add nearly 3 million jobs in impact sensitive industries during the next several decades, with this employment projected to represent more than 15 percent of the overall employment growth in these areas (Table 4-10).

Impacts from alternatives 2 and 3 will be less than the proposed action. This is especially true for alternative 3 that has no leasing in the Eastern Gulf of Mexico Planning Area. Impacts in the eastern Gulf could be slightly greater if alternative 4 were adopted.

Conclusion: In summary, routine operations associated with the proposed action could create small employment, income, and population growth throughout the Gulf of Mexico coastal areas. These effects are most notable in the central Gulf coastal communities. The incremental impact of the proposed action (relative to OCS and non-OCS cumulative scenarios) would be **minor**. In areas with a large proportion of impact sensitive industry, the potential incremental impacts of proposed action oil spills (relative to OCS and non-OCS cumulative accident scenarios) would have **minor** effects. For all other areas, the incremental impact of proposed action oil spills to the OCS and non-OCS cumulative scenarios would be **negligible**. Routine and accident impacts associated with the proposed action add, at most, a **minor** component to cumulative OCS impacts on population, employment, and regional income across the Gulf Coast region.

4.8.2.12. Land Use and Existing Infrastructure

The proposed action does not alter the OCS cumulative scenario enough to substantially change impacts for any of the Gulf of Mexico Planning Areas. For non-OCS activities, community change may continue as landscapes change and adapt to general economic development. Changes in both public and private infrastructure can affect communities in different ways, and impacts can occur from many non-OCS activities, as discussed in Section 4.8.1.2. These impacts are associated with activities such as dredging and marine disposal, general coastal and community development, municipal wastes and other effluents, nonenergy minerals, State oil and gas development, domestic transportation of oil and gas, and foreign crude oil imports. The most likely sources of infrastructure stress from OCS activities are associated with concentrated onshore deepwater support activities. These land bases are well-established under current leasing programs and are part of the OCS cumulative scenario.

Large oil spills from all sources would be expected to have a minor effect on coastal land use and existing infrastructure patterns in all of the Gulf of Mexico Planning Areas.

Conclusion: Generally, impacts on infrastructure from OCS and non-OCS routine activities would be **negligible**; however, **minor** to **moderate** impacts may occur where new land bases are established for deepwater operations. The impact on land use and infrastructure from large oil spills would be **minor**. The contribution of the 2002 OCS Program to these cumulative impacts is expected to be **minor**.

4.8.2.13. Fisheries

4.8.2.13.1. Commercial Fisheries

Routine OCS activities will have some cumulative impacts on commercial fisheries. In particular, space-use conflicts and vessel and drilling noise will have impacts on commercial fisheries in the Gulf of Mexico.

Space-use conflicts will occur because of exploration and delineation activities, and establishment of development and production platforms (Table 4-6a). Small areas will be precluded from commercial fisheries while each of these platforms are in place. A bottom-founded production platform in water depths less than 450 m, with a surrounding 100-m navigational safety zone, requires about 6 ha of space (USDOI, MMS, 1998a). Most commercial trawl fishing in the Gulf of Mexico is performed in water depths less than 200 m (Louisiana Department of Wildlife and Fisheries, 1992). Longline fishing is performed in waters greater than 100 m, and usually beyond 300 m.

Underwater OCS structures such as pipelines could also cause space- and gear-related conflicts (USDOI, MMS, 1999). Conflicts between commercial fishers and the offshore oil and gas industry in the Gulf of Mexico are mitigated by the Fisherman's Contingency Fund. Most pipelines are buried, and those that aren't are weighted with cement coatings (so they do not float) and are covered, usually with concrete mats or similar materials for stability and protection. Most fishing equipment passes over these structures. Fishing hooks, lines, or bottom weights may get snagged in pipeline covers from rod and reel fisheries and bottom longlining.

Increased vessel traffic to and from the rigs and platforms will also increase the amount of marine traffic and possible conflicts with commercial fishers. Frequent radio communications between vessels should avoid most conflicts.

The potential for spatial preclusion also exists in both nearshore or offshore waters with increased levels of seismic survey activity. There is increasing potential for fishing gear (e.g., longlines) to become entangled in the long seismic arrays (streamers) being towed behind seismic survey vessels. In addition, catch efficiency may be affected by the noise generated by seismic activity. Observations either document or suggest that seismic noise may cause a temporary reduction in the commercial fish catch within at least several kilometers of the ensonified area (Chapman and Hawkins, 1969; Lokkeborg, 1991; Skalski et al., 1992; Lokkeborg and Soldal, 1993).

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 are regulated by the USEPA and will dilute to background levels within 1,000 m of the discharge point and have a negligible effect on Gulf of Mexico fisheries.

Non-OCS activities, such as competition between fisheries, coastal development, commercial shipping, dredge and fill activities, marine mining, and water quality degradation, may also impact commercial fisheries. The effects of increased levels of OCS- and non-OCS-related vessel traffic on estuarine nursery areas may also produce adverse impacts to species of commercial importance that use these habitats.

Competition between large numbers of commercial fishers, commercial operations employing different fishing methods, and commercial and recreational fishers for a given fishery resource increase pressure on the fisheries stocks and have a major effect on population size. Space-use conflicts can result from different forms of commercial operations. Some types of gear destroy bottom habitat by dragging heavy equipment over and into the sediments. Nonselective fishing tactics may inadvertently catch immature fish or other by-catch which has a devastating impact on future year classes and prey species of commercially important fish.

Loss of wetlands due to dredging and filling may negatively impact many of the Gulf of Mexico fish species which use these areas as nursery habitat.

A comparison of oil spills under the proposed action and the OCS cumulative scenario is provided in (Table 4-1e and 4-6c**)**. The effects of spilled oil on commercial fisheries include fishing ground area closures, contaminated fish, fouled fishing gear and associated equipment and degradation of fishing grounds. Accidental oil releases from non-OCS activities are possible anywhere on the OCS or in state waters (i.e., from vessel collisions or transfer/lightering operations). Based on available data, total volumes of non-OCS related spills are expected to be much greater (perhaps by an order of magnitude) than total spill volumes from OCS activity.

It is estimated that as many as 76 large oil spills could occur in the Gulf of Mexico from all sources over a 60-year period. Each of these spills will preclude a small amount of fishing area. Offshore spills will most likely remain intact for a short period of time, and commercial fisheries can return to the area. However, shallow coastal spills may contaminate and close some commercial fisheries. For instance, oyster beds and shallow benthic fisheries may be affected.

Conclusion: The overall cumulative impacts from OCS and non-OCS activities would be **minor** to **moderate**. Some commercial fisheries capture methods have severely reduced future year classes by taking juveniles as by-catch. The overall cumulative impact from Federal OCS, State waters and import tanker spills would be **minor** to **moderate**. **Minor** impacts are estimated from the combined routine activities and spills associated with the 2002 OCS Program.

4.8.2.13.2. Recreational Fisheries

Impact producing factors and associated cumulative effects to recreational fisheries from routine OCS operations include space-use conflicts. Conflicts are usually minimal as compared to some types of commercial fisheries. However, there is recreational shrimp trawling for wild shrimp, and trawls can become entangled with OCS structures in the water. Recreational rod and reel anglers often target oil and gas platforms because these structures act as FAD's.

Noise from rig and platform installation may scatter some groundfish away from their homing area. This may result in decreased recreational catch, but most fish will return once the noise quits. Platform removal using explosives may impact recreational fisheries. The noise will drive some fish away. Some fish will be killed, and a structure that may be targeted as a fishing location by recreational anglers could be eliminated.

Non-OCS activities also have the potential to adversely affect recreational fisheries, with most impacts occurring in nearshore coastal waters. Recreational fisheries may be affected by coastal development, commercial fishing, commercial shipping, dredge and fill activities, and marine mining.

Oil spills can affect recreational fishers in ways similar to those stated above for commercial fishers—fouling gear with oil, tainting the catch, and degrading water quality and fishing grounds–all of which could occur as a result of either OCS or non-OCS cumulative activities.

The OCS oil spills most likely to affect the recreational anglers would be the shallow water spills since the recreational anglers are less likely to venture far offshore. As many as 47 large non-OCS spills are assumed to occur throughout the Gulf of Mexico. Most recreational fishing is conducted close to shore. It is unlikely that all of these assumed spills will occur inshore. Therefore, the overall impact of these spills on recreational fisheries will be less than would be expected for the commercial fisheries, some of whom stay out at sea for several days during one trip.

In addition, public perception of the effects of a spill on marine life and its extent may ultimately result in a loss of revenue for the fishing-related recreation industry. Party and charter boat recreational fisheries often have loss of income because of reduced interest in fishing when a spill has occurred. Local hotel, restaurant, bait and tackle shops, and boat rental companies associated with recreational fisheries may experience reduced sales because of public perception of the effects of an oil spill.

Conclusion: The overall impact of both OCS and non-OCS routine operations on recreational fisheries are expected to be **minor**. The cumulative impact of OCS and State oil and gas activities and import tanker spills would be **minor**. The incremental impact of oil spills under the 2002 OCS Program would be **minor**.

4.8.2.14. Tourism and Recreation

The major impact producing factors from OCS and State oil and gas activity that could potentially affect recreation and tourism include offshore structures, pipeline emplacements, support services (helicopter and vessel traffic), and trash and debris. A total of approximately 4,000 platforms currently exist in Federal waters of the Gulf of Mexico, and most of these are off the coast of Louisiana and Texas. Approximately 1,000 additional oil and gas structures exist in State waters off the coasts of Louisiana, Texas, and Alabama. These structures function as artificial reefs and attract fish and fishermen, especially in nearshore waters. New platforms from the proposed action and future programs will replace some of the expected removals (Table 4-6a). By the year 2047, from 4,000 to over 10,000 platforms may have been removed from Federal waters offshore Louisiana and Texas. It is expected that some of the retired oil and gas platforms will be used as artificial reefs. Both recreational fishermen and charter boats frequently target their efforts near oil and gas platforms when these structures are in the scope of their fishing range. Petroleum structures placed in nearshore lease tracts within 10 miles of coastal beach parks and wilderness areas may disturb ocean views and the enjoyment of beach users.

Construction of pipeline landfalls across recreational beaches would temporarily remove less than a mile of beach from recreational use during the construction period. Over the next 60 years, transportation of men, equipment, and supplies to offshore oil and gas operations would result in numerous helicopter trips and service vessel trips per week (Table 4-6a). Noise and boat wakes associated with petroleum transportation operations in conjunction with other commercial, recreational, and industrial transportation activities ongoing in the Gulf will cause intermittent disturbance to the ambience of some coastal recreational experiences, causing minor, temporary impacts.

Offshore oil and gas operations, merchant shipping operations, commercial fishing, naval operations, recreational fishing, cruise ships, and beach users themselves contribute trash and debris to Gulf Coast beaches, affecting the aesthetics of coastal beach park and recreation areas. Texas and Louisiana have been removing over a ton of trash per mile of beach annually. Padre Island National Seashore has been most seriously affected by marine debris, but all coastal beach parks are affected. Historically, oil and gas operations are believed to be responsible for 10-12 percent of beach trash loads, but new operational practices and marine education programs are expected to greatly reduce their contributions. Marine debris is not expected to cause park and recreation area closures, but it may lead to a loss of visitation at some parks and contribute to a decline in the quality of recreational experiences causing moderate impacts. Other non-OCS activities which could affect tourism and recreation include dredging and disposal, coastal development, and municipal waste. The contribution of routine activities from the proposed action to cumulative impacts to recreation and tourism would be negligible.

Large oil and petroleum product spills could occur over the next 60 years (Table 4-6c) and cause temporary closure (up to 6 weeks) of park and recreation areas along the Gulf Coast and could affect a tourism loss at the local level. The most likely source of OCS-related offshore oil spills is pipelines which are concentrated in the central Gulf. The most likely location for contact is along a stretch of coast extending from western Louisiana to eastern Texas. It is estimated that as many as 47 large oil spills could occur over a 60-year period from import tankering in the Gulf of Mexico. Spills from OCS operations or import tankers occurring in proximity to recreational beaches and coastal parks could result in shoreline oiling, leading to closure of these parks and beaches during cleanup operations which can last from 2 to 6 weeks.

Conclusion: Coastal recreation areas from Texas to Florida could be affected by the sight, sounds, and residuals (trash, debris, tar balls, drilling rigs) of continued commercial, recreational, and industrial development and use of the Gulf of Mexico and associated coastal areas. These chronic intrusions into coastal park and recreation areas would result in **negligible** to **minor** impacts. If oil spills from import tankers and OCS activities were to contact the shore, localized beach closures could result and cause **moderate** impacts. The contribution of the 2002 OCS Program to cumulative impacts would be **minor.**

4.8.2.15. Sociocultural Systems and Environmental Justice

Characterization of the Gulf of Mexico's sociocultural systems (Section 3.1.3.5) suggests that the historical impacts of offshore oil and gas activities on the sociocultural environment have not been sweeping regional effects. Impacts, including how communities respond to fluctuations in industry activity, vary from one coastal community to the next (Section 4.3.2.15). While regional impacts may be unnoticed or very limited, individual communities may or may not realize adverse sociocultural impacts. As noted in Section 4.3.2.15, expansion or contraction of offshore or onshore oil and gas activity has produced moderate impacts in some communities, whereas other communities have dealt with episodes of rapid industry change with negligible to minor impact. The proposed action scenario has been discussed previously and is summarized in Table 4-1a Further, non-OCS activities also have the potential for sociocultural impacts (Section 4.8.1.2). 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, religion). The location of new onshore infrastructure is determined by industry based on economic and logistical considerations and is not regulated by the MMS. It is possible that new onshore infrastructure could be located near minority and/or low-income populations. The proposed action scenario includes the addition of new landfalls, new shore bases, and new waste facilities, with no new processing facilities. This onshore activity has the potential of creating environmental justice effects. Lafourche Parish, for example, is already serving as one of the only deepwater servicing facilities on the Gulf Coast. However, socioeconomic impacts occurring in supply and fabrication ports along the Gulf of Mexico would likely have impacts at the community level rather than at a specific minority/low income group level.

Impacts of oil spills on sociocultural systems could vary considerably depending upon the total volume of oil reaching land and the sensitivity of sociocultural systems to oil impacts. Sociocultural systems at greatest risk would be those that are most closely tied to the marine environment. Generally, cumulative sociocultural impacts would be similar to those noted for other socioeconomic components considered—population, employment, regional income, land use, existing infrastructure as well as the social institutions discussed above.

Conclusion: The overall cumulative impact to sociocultural systems from routine oil and gas activities and non OCS-related effects is expected to be **negligible** to **minor**. The overall impact from large oil spills that were to contact land could be **moderate.** The contribution of the 2002 OCS Program to these cumulative impacts is expected to be **minor**.

4.8.2.16. Archaeological Resources

The following analysis considers the effects of trawling; sport diving; commercial treasure hunting; tropical storms; channel dredging; and activities associated with the proposed action, and prior and future OCS sales in the Gulf of Mexico. Specific types of impact-producing factors related to OCS mineral development considered in this analysis include drilling rig and platform emplacement, pipeline emplacement, anchoring, new onshore facilities, ferromagnetic debris associated with OCS activities, and oil spills.

Prehistoric Resources

Offshore development could result in an interaction between a drilling rig, platform, pipeline, or anchors and an inundated prehistoric site. This direct physical contact with a site could destroy artifacts or site features and could disturb the stratigraphic context of the site. The result would be the loss of archaeological data on prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts for the Americas and the Caribbean.

Since 1973, the MMS has required that an archaeological survey be conducted prior to development of mineral leases determined to have potential for prehistoric archaeological sites. The high-probability area for the occurrence of prehistoric sites in the Gulf of Mexico includes all areas of the continental shelf shoreward of the 45-m isobath. It is assumed that the archaeological survey has effectively mitigated most impacts from routine operations related to OCS mineral exploration activities. However, impacts to prehistoric resources may have resulted from OCS routine activities prior to the implementation of the archaeological survey requirement in 1973, but the magnitude of this possible impact is impossible to quantify.

Onshore development could result in direct physical contact between the construction of new onshore facilities or pipeline trenches and previously unidentified prehistoric sites. This direct physical contact with a prehistoric site could cause physical damage to, or complete destruction of, information on the prehistory of the region and North America. Federal and State laws and regulations initiated in the 1960's began requiring archaeological surveys prior to permitting any activity that might disturb a significant archaeological site. Therefore, it can be assumed that, since the introduction of the archaeological resource protection laws, most coastal archaeological sites have been located, evaluated, and mitigated prior to construction. However, impacts to coastal prehistoric resources may have resulted from onshore construction activities prior to enactment of the archaeological resource protection laws, but the magnitude of this possible impact is impossible to quantify.

Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high probability for prehistoric archaeological sites as they are associated with drowned river valleys, which are known to have a high probability for prehistoric sites (Coastal Environments, Inc. [CEI], 1977). It is assumed that some of the archaeological data that have been lost as a result of dredging have been significant and unique; therefore, the impact to prehistoric archaeological sites as a result of past channel dredging activities has probably been moderate to major. In many areas, the U.S. Army Corps of Engineers (COE) now requires remote sensing surveys prior to dredging activities to minimize such impacts (Espey, Huston & Associates, 1990).

Trawling activity in the Gulf of Mexico only affects the uppermost portion of the sediment column (Garrison et al., 1989). This zone would already be disturbed by natural factors relating to the destructive effects of marine transgression and continuing effects of wave and current action. Therefore, the effect of trawling on most prehistoric archaeological sites would be minor.

Tropical storms and hurricanes are yearly occurrences in the Gulf of Mexico. These storms have impacted all areas of the Gulf from west Texas to south Florida (cf. DeWald, 1980), and broad areas are affected by each storm. Prehistoric sites in shallow waters or coastal beach sites are exposed to the destructive effects of wave action and scouring currents during these events. Under such conditions, it is highly likely that artifacts would be dispersed and the site context disturbed, resulting in the loss of archaeological information. Overall, a significant loss of data from nearshore and coastal prehistoric sites has probably occurred, and will continue to occur, from the effects of tropical storms. It is assumed that some of the data lost have been significant and/or unique, resulting in a moderate to major level of impact.

The cumulative case scenario includes assumptions of the number, size, and probability of occurrence of oil spills from OCS activities and an estimate of the number of large spills from import tankers (Table 4-6c). An accidental oil spill could impact coastal prehistoric archeological sites. Archaeological resource protection during an oil spill requires specific knowledge of the resource's location, condition, nature, and extent prior to impact; however, the Gulf of Mexico coastline has not been systematically surveyed for archaeological sites. Existing information indicates that, in coastal areas of the Gulf, prehistoric sites occur frequently along the barrier islands and mainland coast and the margins of bays and bayous. Thus, any spill that were to contact the land would involve a potential impact to a prehistoric site.

Heavy oiling of a coastal area (Whitney, 1994) could conceal intertidal sites that may not be recognized until they are inadvertently damaged during cleanup. Crude oil may also contaminate organic material used in Carbon-14 (^{14}C) dating, and, although there are methods for cleaning contaminated ^{14}C samples, greater expense is incurred (Dekin et al., 1993). The major source of potential impact from oil spills is the harm that could result from unmonitored shoreline cleanup activities. Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with effective training and supervision. Damage or loss of significant archaeological information could result from the contact between an oil spill and a prehistoric archaeological site, but it is unlikely that entire sites would be destroyed without any mitigation during cleanup activities; therefore, the cumulative impact from oil spills to prehistoric archaeological sites would probably be moderate.

Historic Resources

Direct physical contact between a routine activity and a shipwreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb the site context. The result would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel's crew, and the concomitant loss of information on maritime culture for the time period from which the ship dates.

Since 1973, the MMS has required that an archaeological survey be conducted prior to development of mineral leases determined to have potential for historic-period shipwrecks. The high-probability area for the occurrence of historic-period shipwrecks in the Gulf of Mexico consists of nearshore areas, port vicinities, and ship-specific polygons (Figure 3-20). It is assumed that the archaeological survey has effectively mitigated most impacts from routine operations related to OCS mineral exploration activities. However, impacts to historic-period shipwrecks may have resulted from OCS routine activities prior to the implementation of the archaeological survey requirement in 1973, but the magnitude of this possible impact is impossible to quantify.

Onshore development could result in direct physical contact between the construction of new onshore facilities or pipeline trenches and previously unidentified historic sites. Federal and State laws and regulations initiated in the 1960’s began requiring archaeological surveys prior to permitting any activity that might disturb a significant archaeological site. Therefore, it can be assumed that, since the introduction of the archaeological resource protection laws, most coastal archaeological sites have been located, evaluated, and mitigated prior to construction. However, impacts to coastal historic sites may have resulted from onshore construction activities prior to enactment of the archaeological resource protection laws, but the magnitude of this possible impact is impossible to quantify.

With regard to non-OCS activities in the Gulf of Mexico, trawling activities would only affect the uppermost portion of the sediment column (Garrison et al.1989). On many wrecks, this zone would already be disturbed by natural factors and would contain only artifacts of low specific gravity (e.g., ceramics and glass) which have lost all original context. Therefore, the effect of trawling on most historic shipwreck sites would be minor.

Sport diving and commercial treasure hunting are significant factors in the loss of historic data from shipwreck sites. While commercial treasure hunters generally impact wrecks with intrinsic monetary value, sport divers may collect souvenirs from all types of wrecks. It is assumed that some of the data lost have been significant and/or unique. The known extent of these activities suggests that they have resulted in a major impact to historic-period shipwrecks.

Tropical storms and hurricanes are yearly occurrences in the Gulf of Mexico. These storms have impacted all areas of the Gulf from west Texas to south Florida (cf. DeWald,1980), and broad areas are affected by each storm. Shipwrecks in shallow waters and coastal historic sites are exposed to a greatly intensified longshore current and high energy waves during tropical storms (cf. Clausen and Arnold, 1975). Under such conditions, it is highly likely that artifacts of low specific gravity would be dispersed. Some of the original information contained in the site would be lost in this process, but a significant amount of information may also remain. Overall, a significant loss of data from historic sites has probably occurred, and will continue to occur in the Gulf of Mexico from the effects of tropical storms. It is assumed that some of the data lost has been significant and/or unique, resulting in a moderate to major level of impact.

Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high probability for historic shipwrecks, and the greatest concentrations of historic wrecks are likely - associated with these features (cf. Garrison et al, 1989). Assuming that some of the data lost have been unique, the impact to historic sites as a result of past channel dredging activities has probably been moderate to major. In many areas, the COE now requires remote sensing surveys prior to dredging activities to minimize such impacts (Espey, Huston & Associates, 1990).

Past, present, and future oil and gas exploration and development on the OCS will result in the deposition of tons of ferromagnetic debris on the seafloor. This modern marine debris will 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 increases the potential that significant or unique historic information may be lost. However, the MMS requires avoidance or investigation of any unidentified magnetic anomaly prior to permitting bottom-disturbing activities; therefore, the increase in impacts to historic shipwrecks from magnetic masking is probably minor.

The cumulative case scenario includes assumptions of the number, size, and probability of occurrence of oil spills from OCS activities and an estimate of the number of large spills from import tankers (Table 4-6c). An accidental oil spill could impact a coastal historic site, but the direct impact of oil on most historic sites would be temporary and reversible. The major source of potential impact from oil spills is the harm that could result from unmonitored shoreline cleanup activities. Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with effective training and supervision. Damage or loss of significant historic information could result from oil spill cleanup activities, but it is unlikely that entire sites would be destroyed without any mitigation during cleanup activities; therefore, the cumulative impact from oil spills to historic archaeological sites would probably be moderate.

Conclusion: Under the cumulative scenario, the impact to both prehistoric and historic archaeological sites from routine activities should be **minor** due to archaeological surveys which are required prior to disturbance. However, routine activities that were approved prior to initiating the survey requirement may have impacted significant archaeological sites, but the magnitude of this possible impact is impossible to quantify. Of the non-OCS related factors that impact archaeological sites, channel dredging and tropical storms could possibly cause a **major** impact to both prehistoric and historic sites. Commercial treasure hunting and sport diving may also cause a **major** impact to historic-period shipwreck sites. The primary oil-spill impacts to both prehistoric and historic archaeological sites would result from cleanup activities, and it is estimated that this impact would be **moderate**. The incremental contribution of the proposal to the cumulative impacts on archaeological resources should be very small due to the archaeological surveys that are required prior to disturbance.

4.8.3. Alaska Region

4.8.3.1. Water Quality

In addition to effects from the proposed OCS activities, water quality in Alaska may be affected by State and Federal offshore and onshore oil and gas activities and spills of crude oil. Additional impacts may occur from routine discharges of drill muds, cuttings, and produced waters; sediment disturbances (e.g., dredging) resulting in increased turbidity; effluents from onshore mining and mineral processing; release of municipal effluent; discharges by cruise ships and other non-OCS vessels; construction and dredging of local harbors; siltation from logging; and fuel oil and chemical spills from the non-oil industry.

The cumulative case scenario for all OCS oil and gas activities is summarized in Table 4-6b. In contrast to the proposed action alone (Table 4-1b), there is a notable increase in the number of platforms, wells, miles of pipeline, new shore bases, and bottom areas disturbed, especially in the Beaufort Sea and Cook Inlet Planning Areas.

Most non-oil industry impacts occur in localized areas and only affect water quality within a few tens of kilometers. Dredging for the harbor associated with the Red Dog Mine (Hope Basin) would cause some local degradation of water quality, as would other mine effluents from onshore operations. In general, such discharges are rapidly diluted with negligible impacts to local biota (USDOI, MMS, 1996a). Similarly, municipal effluents in Alaskan waters are generally rapidly diluted and of relatively low volume because of the small population and small industrial base of the State. These discharges are regulated by the USEPA. Logging in the Tongass National Forest (Gulf of Alaska) may also influence siltation rates and water quality in coastal marine waters by increasing erosion rates. While localized in area affected, all of these non-OCS activities contribute to a cumulative degradation of water quality in the OCS planning areas. Existing and potential oil and gas activities that impact water quality include causeways; gravel island construction and removal (Beaufort Sea); pipeline dredging; discharges of drill cuttings, drilling muds, and produced waters; and small accidental oil spills.

Causeways currently in place as a result of oil and gas development locally affect turbidity by enhancing sedimentation of suspended loads and by lengthening the period of ice cover within about a 5-km distance. The redirection of flow changes local temperature and salinity regimes within about a 5-km distance offshore of the causeway. No new long causeways are assumed during future development activities.

Gravel placement for construction of artificial islands, platform construction, and dredging trenches for subsea pipeline construction increase turbidity. These impacts are of limited duration and low geographic scope, causing plumes of increased turbidity affecting several square kilometers around the construction site. Removal of gravel islands would result in turbidity plumes of a magnitude similar to construction. During their useful life, gravel production islands are protected from erosion by sandbagging or concrete armor placement. Some small amounts of erosion probably still occur but are limited in magnitude. Following use, islands would be removed or abandoned. If abandoned, storms, ice override, and ice gouging would erode the island over a period of years. Ocean currents would remove finer sediment and create a detectable plume downcurrent for several meters. Abandonment would result in local but persistent turbidity plumes as the island eroded. Fifteen gravel islands have been constructed during past oil and gas exploration in the Beaufort Sea. The Northstar project is currently constructing an island for production facilities, and the proposed Liberty project includes construction of a gravel island and would begin in winter 2003. Additional island construction is additive and cumulative in terms of impacts, but impacts are localized and do not cause a sustained degradation of water quality in the Beaufort Sea, Chukchi Sea, or Hope Basin. Additionally, erosion of gravel barrier islands is a natural part of the nearshore environment in this region.

Discharge of muds and cuttings from exploration and development on existing leases would occur in addition to those expected from the proposed action. Discharges are regulated by the USEPA and would be within water quality criteria at 100 m from the discharge point. Water quality would be reduced during periods of exploration or development drilling, but would rapidly dissipate upon completion.

Produced waters may be reinjected or injected into different formations so that no discharge occurs. However, if produced waters were discharged, substantial impacts to water quality would be restricted to the mixing zone within about 100 m of the discharge point. This degradation of water quality would continue throughout production in each planning area. Under the cumulative scenario, discharge of produced waters would degrade water quality in less than 1 percent of each of the planning areas.

One or more accidental oil spills (≥500 bbl) are likely to occur in the Alaskan OCS environment under the cumulative case scenario, especially in the Beaufort Sea and Chukchi Sea Planning Areas. The cumulative scenario (including the proposed action) considers pipeline (4,600 bbl) and platform (1,500 bbl) spills in the Beaufort Sea, Chukchi Sea, and Cook Inlet Planning Areas, and tanker spills (7,800 bbl) possibly off the Gulf of Alaska coast (Table 4-6c). Degradation of water quality is highly dependent upon the size and frequency of spills. Sustained degradation of water quality above State and Federal criteria for hydrocarbon contamination is unlikely, but could occur in areas up to several thousand square kilometers during large scale spill events (USDOI, MMS, 1996a). The likelihood of this occurring depends upon the size, location, and season of the spill.

Water quality degradation by accidental spills is cumulative with spills from other industry and recreational activities. These effects could be additive, increasing the level of hydrocarbon contamination in the Alaskan environment, but would likely be of short duration. Non-oil industry spills of petroleum products and chemicals typically affect water quality within a few tens of kilometers of the spill sites. Spills of a few to several hundred barrels are relatively common in Alaska, and impacts are highly dependent on the rate, amount, and type of product spilled (USDOI, MMS, 1996a).

The estimated probability of one or more large spills (> 500 bbl) occurring from all OCS activities from the cumulative case is provided in Table 4-6c. The probability of such a spill occurring is estimated as 16-18 percent (Cook Inlet), 81-94 percent (Beaufort Sea), and up to 98 percent (Chukchi Sea). Possible large spills from State oil and gas development and from tankers (Gulf of Alaska) are not considered in these estimates.

Overall, impacts to water quality from routine activities are expected to be minor, generally limited in time and/or area affected. Impacts from large accidental oil spills, if such spillage were to occur, would be minor to moderate. Because there is no tanker import (foreign or domestic) in Alaska, the contribution in impact from the proposed action to the cumulative impact would be substantial. Thus, the impact levels for the proposed action and the cumulative scenarios are essentially the same.

Conclusion: Water quality impacts due to routine activities under the cumulative case would be **minor**. If large oil spills were to occur, they would likely result in **minor** to **moderate** impacts to water quality.

4.8.3.2. Air Quality

The cumulative analysis considers the impacts from future OCS oil and gas development, emissions on the OCS that are not associated with oil and gas development, and onshore emissions.

Air quality in Alaska is relatively pristine due to the lack of large industrial emission sources as well as sizable population centers. Alaska has the lowest emission rates of all the U.S. States. The primary industrial emissions are associated with oil and gas production, power generation, small refineries, paper mills, and mining. While some growth of these activities is likely to take place in the future, overall emissions will remain low. More stringent emission standards on motor vehicles and new USEPA standards on nonroad engines and marine vessels would tend to result in a downward trend in emissions.

On the Alaska North Slope, onshore oil production from the Prudhoe Bay, Kuparuk, Milne Point, and Badami fields and oil production from the Duck Island field in State waters are the largest source of emissions. Production from North Slope reservoirs peaked at about 2 million bbl of oil per day in 1988, and declined to 1.45 million bbl per day in 1995. Production is predicted to decline to 0.94 bbl per day by 2005 and to 0.29 bbl per day by 2020 (COE, 1999). There are a number of planned and potential future oil development projects onshore and in State and Federal waters. In addition, there is the possibility of development in the National Petroleum Reserve-Alaska (NPR-A). It is not known whether development in those areas would cumulatively offset the declining North Slope production levels. Without substantial new future developments, overall production levels in the region would continue to decline. Ambient air quality monitoring in the existing North Slope oil production areas has shown that air pollutant levels are well within Federal and State standards. Overall, emissions in the area are expected to decrease due to the decline of North Slope production over the next two decades so air quality in the future should be the same or better than present levels.

There are very few existing emission sources in the Chukchi Sea, Hope Basin, and Norton Basin areas. There may be a potential for oil development in the NPR-A adjacent to Chukchi Sea. Very little future development is anticipated around the Hope and Norton Basins. Air quality levels are expected to remain relatively pristine.

Existing emission sources in the Cook Inlet area include oil production activities in State waters, onshore petroleum processing and refining, onshore oil and gas production, marine terminals, and commercial shipping. Oil production in State waters is relatively small and is declining. Any potential future development in State waters is expected to be small. Overall, emissions in the area are not expected to change significantly in the future. Existing air quality is well within the Federal and State standards and is not expected to change significantly.

The effects of OCS oil and gas development on air quality in Alaska is discussed in Section 4.3.3.2. Modeling studies of OCS emission sources have indicated that concentrations of NO_2, SO_2, and PM_{10} are within the PSD incremental limits and the NAAQS. It was concluded that pollutant concentrations from the proposed 5-year program would be within the PSD incremental limits and the NAAQS. Air quality modeling of individual facilities shows that maximum concentrations of NO_2, SO_2, and PM_{10} occur within about 200 m of the facility and are considerably lower at distances greater than 1 km (USDOI, MMS, 2001). There would, therefore, be little cumulative interaction between facilities that would be located some distance apart. The projected levels of cumulative OCS activities for the Beaufort and Cook Inlet Planning Areas are about double that of the levels for the proposed 5-year program activities. However, because the individual activities would likely be separated over some distance, rather than clustered, the impacts would not be expected to be significantly greater. Air quality modeling for OCS development in the Cook Inlet Planning Area indicated that pollutant concentrations within the Tuxedni National Wilderness Area would be within the PSD Class I increments.

The formation of ozone in the atmosphere is favorable when there are significant sources of NO_x and VOC in the area under conditions of stable atmosphere and relatively high temperatures. Conditions in Alaska are seldom favorable for significant ozone formation. Ambient ozone levels in Alaska are well within the Federal standards. Any emissions from OCS oil and gas activities would be relatively small and dispersed. These activities would not be expected to contribute significantly to ambient ozone levels.

Gaseous and fine particulate matter in the atmosphere can potentially degrade atmospheric visibility. The most important source of visibility degradation is from particulate matter in the 1- to 2-micron size range. These particles are directly emitted into the atmosphere through fuel burning. However, other sources arise through chemical transformation of NO_2, SO_2, and VOC into nitrates, sulfates, and carbonaceous particles. Existing visibility in Alaska is generally good because of the absence of large emission sources. The phenomenon of arctic haze, which occurs in northern Alaska in winter, is attributed primarily to long-range transport of pollution sources from the Eurasian continent. Any increases in local emission sources in Alaska should not have any effect on the arctic haze phenomenon.

A visibility screening model applied to a planned OCS facility in the Beaufort Sea showed a noticeable effect on visibility on only a very limited number of days, ones that had the most restrictive meteorological conditions. No effects were simulated during average conditions (USDOI, MMS, 2001). The screening method overestimates impacts; therefore, it is not known if the modeled impacts are real. It is not known to what extent aggregate OCS sources contribute to visibility reductions. However, the individual emission sources from the proposed 5-year program as well as for the cumulative OCS sources are relatively small and scattered over a large area, and it is not expected that, as a whole, they would have a measurable impact on visibility.

The cumulative impact on air quality from all onshore and offshore emission sources would be minor. The contribution of emissions from the proposed 5-year program would be minor.

Small accidental oil spills would cause small, localized increases in concentrations of VOC due to evaporation of the spill. Most of the emissions would occur within a few hours of the spill and would decrease drastically after that period. Large spills would result in emissions over a large area and a longer period of time. A discussion of the effects of oil spills on air quality is presented in Section 4.3.2.2. A spill in the Arctic Ocean during broken-ice or melting-ice conditions could result in more concentrated emissions over a smaller area than would be the case under open-water conditions. In a large spill occurring under the ice, the oil would remain trapped and be dispersed under the ice until melting or breakup occurs. Emissions would then occur at a slower rate and would be dispersed over a wider area.

In situ burning of a spill results in emissions of NO_2, SO_2, CO, and PM_{10} and would generate a plume of black smoke. A discussion of the effects of in situ burning is presented in Section 4.3.2.2. Studies of in situ burn experiments have shown that air quality impacts are localized and short-lived and that pollutant concentrations do not pose a health hazard to persons in the vicinity.

In the cumulative scenario, there would be two additional large oil spills in the Beaufort Sea Planning Area compared to the predicted number of spills for the proposed 5-year program. There would be about double the number of small oil spills in the Beaufort and Cook Inlet Planning Area. However, the effect of an individual spill would not change. Only the probable number of spills would increase. The air quality impacts for the cumulative case would, therefore, be the same as those associated with the proposed 5-year program.

In summary, any air quality impacts from oil spills would be localized and of short duration. Emissions do not appear to be hazardous to human health. The impacts from in situ burning are also very temporary. Pollutant concentrations would be expected to be within the NAAQS. The air quality impacts from oil spills and in situ burning would therefore be minor.

Conclusions: The cumulative air quality impacts from all sources, including small oil spills, would be **minor**. Air quality impacts from large oil spills would be **minor**. The air quality impacts from the proposed 2002 OCS Program, including effects from small or large oil spills, would be **minor**.

4.8.3.3. Marine Mammals

4.8.3.3.1. Cetaceans

Past commercial whaling of bowhead, blue, fin, humpback, sei, sperm, gray, and right whales in Alaskan waters left whale stocks depleted and more susceptible to disturbance from human activities. There is growing concern that pollutant levels in arctic marine mammal species may be affecting both the animals and the Alaska natives who rely on them for subsistence purposes. Persistent organic pollutants (such as polychlorinated biphenyl [PCB] and dichlorodiphenyltrichloroethane [DDT]) and heavy metals (such as mercury, cadmium, and lead) persist in the environment and magnify through the food chain. Beluga whales and harbor porpoise eat fish and have higher contaminant levels than the minke whale, which mostly eats invertebrates. The effects of high contaminant levels of persistent organic pollutants on marine mammals include malformations in reproductive organs, fewer young, and failure to reproduce. Reduced testosterone levels in Dall's porpoise (Subramanian et al., 1987) may be linked to dichlorodiphenyldichloroethylene (DDE) and possibly PCB contamination. In general, what little data exists indicates that other marine mammals, including beluga whales, have elevated levels of PCB's. The Alaska Native Science Commission reports that traditional ecological observations made by Native people increasingly note the presence of diseases and abnormalities in the wildlife species they rely upon for food.

Alaska Natives have been hunting bowheads for at least 2,000 years throughout the arctic (Marquette and Bockstoce, 1980; Stoker and Krupnik, 1993). Alaska Natives take approximately 0.1-0.5 percent of the bowhead population each year through subsistence hunting (Philo et al., 1993b). Since 1977, the number of kills ranged from 14 to 72 per year (Stoker and Krupnik, 1993). Currently, nine Alaska Native communities harvest bowheads. The annual quota for each village is dependent on the bowhead population size and growth and the population size of individual North Slope communities. The subsistence harvest is set at a sustainable level; however, the subsistence harvest is the greatest contributor to human-caused mortality of bowheads. Impacts are expected to be minor.

From 1993 to 1997, the average annual subsistence take of belugas in the Alaskan Beaufort Sea stock was 61 individuals (Frost and Suydam, 1995; Frost, 1998). However, the average number of belugas harvested between 1993 and 1997 is negatively biased because reliable estimates of whales struck and lost are not available before 1996 (Hill and DeMaster, 2000). In the Canadian Beaufort Sea, the annual subsistence take of belugas averaged 123 individuals between 1993-1997. With the U.S. and Canadian harvests combined, the mean estimated subsistence take of Beaufort Sea belugas during 1993-1997 is 184 whales (Hill and DeMaster, 2000). The mean annual take of beluga whales in the eastern Chukchi Sea stock for the period of 1993-1997 is 68. However, this estimate is also negatively biased due to a lack of reliable estimates before 1995. Cumulatively, subsistence harvest comprises a major source of mortality for belugas throughout their arctic range.

The decline of Cook Inlet belugas is attributed primarily to subsistence harvest by Alaska Natives. Mean annual take between 1995-1997 is estimated at 87 individuals. Currently, there is a moratorium on harvesting Cook Inlet belugas. Future harvest levels have yet to be determined. The recovery rate of the Cook Inlet stock would be affected by the current low population and the potentially skewed age distribution because of the previous overharvest. Any harvest of belugas in Cook Inlet would have a major impact on the population.

Gray whales have been traditionally harvested in Alaska and Russia. The most recent reported harvest occurred in 1989 (International Whaling Commission [IWC], 1991). The annual subsistence take in Russia during the period of 1993 to 1995 was 43 gray whales, while the average number of whales harvested between 1968 and 1993 was 159 per year (IWC, 1995). Currently, the IWC quota for gray whales taken by Native peoples is 140.

There is very little subsistence hunting of minke whales by Alaska Natives. Only seven minke whales were reported taken between 1930 and 1987 (Hill and DeMaster, 1999). The most recent harvest (two whales) occurred in 1989 (IWC, 1991). Current and past harvest level alone negligibly impact the minke whale population.

Commercial fisheries can also impact whale species by incidental take, entanglement, and collisions with fishing vessels. Fishing vessel traffic could temporarily disturb whales, and interactions between some baleen whales and fisheries targeting forage fishes may exist. In areas where fishing vessel activity becomes too great, whale distribution may be altered, or interactions with fishing gear may increase. Limited fisheries activities occur in bowhead habitat in the Beaufort and Chukchi Seas, due to sea ice. No injuries or mortalities were reported from vessel operators between 1990 and 1996 (Hill and DeMaster, 1999). The current estimated annual mortality rate incidental to commercial fisheries is zero and is, therefore, unlikely to contribute to the cumulative effects of human development on the bowhead population.

Direct mortality or reduced fitness of whales can be caused by encounters with fishing or other submerged gear and blunt trauma by ship strike. Hill and DeMaster (1999) estimated a minimum mortality rate incidental to commercial fisheries for humpback whales in Alaska and Hawaii to be 1.0 whales per year.

While there were no reported mortalities of sperm whales incidental to observed commercial fisheries from 1990 to 1996 (Hill and DeMaster, 1999), mortalities of sperm whales resulting from interactions with longline fisheries in the Gulf of Alaska occur and may be increasing in frequency (Hill and Mitchell, 1998). Between 1995 and 1997, fisheries observers recorded several instances where longline fishermen interacted with sperm whales that were feeding from longlines. Future conflicts between longline fisheries and sperm whales and the use of acoustic harassment devices may, over time, have a minor to moderate effect on the behavior and productivity of sperm whales.

The effect of commercial fisheries on belugas varies among the Alaska Planning Areas. In the Beaufort Sea, there have been no reported mortalities resulting from interactions with commercial fishing in recent years (Hill and DeMaster, 2000). Gillnet fisheries operate in the nearshore waters of the eastern Chukchi Sea. However, no incidental mortalities of belugas have been reported in conjunction with this fishery or the Bering Sea (and Aleutian Islands) groundfish trawl, longline, and pot fisheries (Hill and DeMaster, 2000). In Cook Inlet, belugas could potentially come into contact with purse seines, drift gill nets, and set gill nets. Between 1990 and 1997, self reported fisheries data did not indicate any mortality of belugas incidental to these fisheries (Hill and DeMaster 2000). In 1999, an observer program was initiated for the Cook Inlet set gill net fisheries, and there were no recorded interactions with belugas (Fadely, 2000, oral commun.).

Commercial fisheries could also impact gray whales. Between 1990 and 1995, boat-based observers monitored six different fisheries for incidental take; no mortalities of gray whales were reported incidental to any of these fisheries (Hill and DeMaster, 2000). However, logbook reports between 1990 and 1993 recorded two gray whale mortalities related to the Bristol Bay gill net fisheries (Hill and DeMaster, 2000). Currently, most Alaska gill net fisheries do not have observer programs in place, making estimated fisheries mortality unreliable and probably negatively biased. Entanglement in fishing gear from other Alaskan fisheries is a potential source of mortality in gray whales. Stranded gray whales have been found entangled in gill nets in 1987 on the Alaska Peninsula and in 1988 in Yakutat.

Historically, minke whales have been caught in both coastal set gill nets and offshore drift gill nets (Small and DeMaster, 1995). However, in the period of 1990-1993, logbook data did not report any injuries or mortalities of minke whales incidental to these fisheries. Between 1990 and 1995, NMFS observers monitoring six different commercial fisheries did not report any mortalities of minke whales. The current estimated annual mortality rate for minke whales incidental to commercial fisheries is zero. Therefore, commercial fisheries contribute a negligible increase, if any, to the cumulative effects of human activities on minke whales.

The NMFS observers monitored the Bering Sea (and Aleutian Islands) and Gulf of Alaska groundfish trawl, longline, and pot fisheries from 1990 to 1996 (Hill and DeMaster, 1999). Killer whale mortalities were reported in the Bering Sea groundfish trawl and longline fisheries. The estimated minimum annual mortality of killer whales incidental to U.S. commercial fisheries based on observer data is 0.8 whales per year (Hill and DeMaster, 1999).

An additional source of mortality of killer whales is due to interactions between killer whales and the blackcod fishery (Dahlheim, 1988; Yano and Dahlheim, 1995). Surveys conducted in the Bering Sea and western Gulf of Alaska in 1992 indicated that 9 of 182 (4.9 percent) individual whales in 7 of the 12 (58 percent) pods encountered had evidence of bullet wounds (Dahlheim and Waite, 1993). In Prince William Sound, the pod that has most interacted with fisheries has experienced a high level of mortality. Between 1986 and 1991, 22 whales from a pod of 37 whales were missing and assumed dead (Matkin et al., 1994). However, the causes of these deaths are unknown (Dahlheim and Matkin, 1994).

Commercial fisheries impact harbor and Dall's porpoises by increasing mortality rates. The estimated minimum annual mortality rate of harbor porpoises and the Gulf of Alaska stock of Dall's porpoises incidental to commercial fisheries are 4 and 25 porpoises, respectively, and is considered a significant source of mortality in the Gulf of Alaska stock of Dall's porpoise (Hill and DeMaster, 1999). Although commercial fisheries contribute to porpoise mortality, their impacts to porpoise populations are negligible.

Whale watching has increased in areas such as the Kenai Fjords, Prince William Sound, Glacier Bay, southeast Alaska, and the Hawaiian Islands. Operational measures to mitigate potential effects exist for both water- and aerial-based whale watching charters. Adherence to guidelines should minimize disturbances to whales, but in areas where the concentration of activity becomes too great, whales may abandon preferred habitat. The NMFS is developing whale watching regulations and guidelines for humpback whale watching activities in southeast Alaska. These potential problem areas are small relative to Cook Inlet/Shelikof Strait and Gulf of Alaska OCS Planning Areas. Increased whale watching could displace fin and humpback whales from critical habitat, along with existing traffic from sport fishing, the Alaska Marine Highway, and commercial cruise ships. Blue, northern right, and sei whales tend to be more pelagic and would therefore be less affected by these activities.

The cumulative case scenario assumes up to 72 exploration wells, 920 production wells, and up to 26 platform emplacements in the Beaufort and Chukchi Seas over a 40-year time period (Table 4-6b). These developments may be located within the spring or fall migratory routes of the bowhead whale. Noise from routine development activities may cause avoidance behavior in the whales (Richardson and Malme, 1993). Bowheads typically avoid vessels from 1 to 4 km, and drilling noise from a drillship may deflect individuals 20 km or more from their migratory path (Richardson and Malme, 1993). Each additional lease sale would increase the amount of routine vessel activity and drill and exploration noise throughout the migration route. If these activities were to deflect a majority of the bowhead whales from their traditional migration routes, the population could experience biological consequences. A change in the migratory corridor could also potentially affect the whale's accessibility to be harvested by Native communities.

Seismic and dredging activity related to oil and gas exploration, in conjunction with other anthropogenic activities, may cumulatively affect bowhead whales by deflecting them from their migration route. Open-water seismic exploration is usually conducted before and during the westward bowhead migration in the Beaufort Sea. Richardson (1999) found that bowheads avoided active seismic operations by 20 km and were seen farther offshore during periods with seismic activity than without seismic activity. Multiple seismic and possibly dredge operations in additional lease areas would increase the probability that migrating bowheads would encounter seismic operations and deflect around those activities. These could, in turn, increase the scope and magnitude of disturbance by deflecting a greater number of whales.

Sperm whales are typically found in waters deeper than 200 m, and are relatively rare in the Alaska OCS Planning Areas. However, additional development may cumulatively impact sperm whales through noise disturbance from routine activities (Clarke, 1956; Gambell, 1968; Mullin et al., 1991). This cumulative disturbance is expected to only have a minor impact on the population.

Cumulatively, noise from routine vessel and aircraft traffic, seismic exploration, drilling operations, and dredging could affect beluga behavior and distribution. Belugas display a variety of behavioral responses, ranging from tolerance to extreme sensitivity, to vessel traffic. In areas where belugas are hunted by boat, small vessel traffic has been known to alter local distribution (Seaman and Burns, 1981; Burns and Seaman, 1985; Caron and Smith, 1990). Intense boating traffic and harassment during beluga tagging operations in the summer did not cause belugas in the Susitna estuary to permanently or temporarily (more than 6 hours) abandon this important feeding area (Shelden, 1995). Lesage et al. (1999) hypothesized that a greater decrease in calling rate of belugas observed during ferry approaches might be due to a greater acoustic overlap in the call frequency used by belugas and the source frequencies of the ferry. In the Chukchi and Beaufort Seas, belugas are most sensitive to drilling activities in the spring, when they are migrating along open leads in the ice. Belugas in leads changed courses when they came within 1 km of a stationary drillship (Norton-Fraker and Fraker, 1982). Thus, additional vessel traffic related to oil and gas exploration in Cook Inlet, as well as in the Beaufort and Chukchi Seas, could potentially cause short-term displacement and behavioral changes of belugas, thus having an overall minor affect.

As with bowhead whales, gray whales are expected to show some disturbance behavior towards oil and gas development activities. Nearby seismic vessels have deflected migrating gray whales (Fidell et al., 1970). It is expected that future OCS oil and gas development could affect gray whales in a manner similar to those described for bowheads. The greatest exposure of gray whales to disturbance by OCS activities would be during migration. Additional offshore developments could cumulatively deflect gray whales from their migratory routes; however, only a minor impact is expected.

Due to their nearshore migration route, gray whales are susceptible to collisions with ships. However, most ship strikes probably go unreported. Therefore, the annual mortality due to ship collisions is estimated at one gray whale per year (Hill and DeMaster, 2000). Combined with subsistence harvest, mortalities due to incidental interactions with commercial fisheries, entanglement in fishing gear, noise due to oil and gas development and exploration, and collisions with ships could have a cumulatively moderate impact on gray whales.

Minke whales are expected to respond like other whales, with general avoidance and varied behavioral responses to most noise producing activities. Increased vessel and aircraft traffic related to OCS oil and gas exploration and development in the Beaufort and Chukchi Seas, as well as the Gulf of Alaska, may displace minke whales in these areas, and would be cumulative with boat traffic related to tourist activity in the Gulf of Alaska. However, cumulatively, these effects are expected to be minor. Subsistence harvest combined with the previously mentioned anthropogenic effects may have negligible to minor cumulative impacts on the Alaska minke population.

Vessel and aircraft activity (Table 4-6b) may displace killer whales from the vicinity of the traffic. Dredging and seismic exploration are expected to cause only minor disturbance, resulting in altered behavior of killer whales. While separately, individual routine OCS operations may only have negligible short-term effects on killer whales; cumulatively, these activities are expected to have negligible to moderate effects on killer whales in Alaska waters.

Routine OCS operations (Table 4-6b) are expected to only have negligible effects on individual porpoises. Noises from platform construction, operation, and removal could disturb harbor and Dall's porpoises, resulting in avoidance of the immediate and surrounding areas. Cumulatively, displacement may have negligible effects at the population level.

Native Alaskans exhibit a keen awareness of ecosystem processes in their assessment of the likely effects of oil spills. Fenton Rexford stated "If there is an oil spill out there [offshore], it will kill off . . . shrimp, crab, . . . [and] phytoplankton, they will all be affected . . . [they] are all tied into the whale and the ugruk [bearded seal]" (at a Northstar hearing, cited in USDOI, MMS, 1999). Archie Brower had much earlier testified that "If there's a major blowout on the ocean, if that happens, the ice goes out, it's going to take that oil all along the coast . . . and it would destroy our fish, seals, and whales" (USDOI, MMS, 1979b).

The number of whales affected by a spill would depend on the time of year and duration of the spill, the quantity of the spill, the density of the whale population in the vicinity of the spill, and the individual whale's ability to avoid the spill. Up to seven large spills are assumed to occur from OCS activities in the Beaufort and Chukchi Seas for the cumulative scenario (Table 4-6c). With increased development in the Beaufort and Chukchi Seas, the probability of an oil spill also increases slightly and thus the likelihood of whales contacting spilled oil. Section 4.3.3.3 reviews the impact of an oil spill on the bowhead and other whales. Cumulative effects from multiple spills, both OCS and non-OCS could potentially affect the magnitude and scope of the impact on the bowhead population. Overall cumulative impacts of oil spills on bowhead whales are expected to be minor.

In the event of a spill, the likelihood of humpback and fin whales encountering the affected area is greater than that for blue, northern right, and sei whales. No direct mortality of any of these species was documented following the 1989 *Exxon Valdez* oil spill (Loughlin, 1994). A large spill, such as assumed for the proposed action, would not go unremediated. However, individuals of these species may not be able to avoid the contaminated area. Any direct mortality of a whale from these stocks could have negative effects at the population level. These large baleen whales reproduce slowly and are still recovering from the past commercial harvest. Depending on the geographic scope, magnitude, and frequency of accidental oil spills, cumulative effects on these whale stocks could range from negligible to minor.

Because sperm whales are sparsely distributed throughout Alaskan waters, impacts from oil spills should be negligible. Similarly, minke whales are not concentrated in specific areas; therefore, the effect on the minke whale population resulting from the cumulative scenario is expected to be negligible to minor. With increased development in the Beaufort and Chukchi Seas, the probability of an oil spill increases; thus, the likelihood of gray whales contacting spilled oil also increases. The effect of the cumulative scenario spills (Table 4-6c) could range from negligible to minor on the gray whale population.

In the Beaufort and Chukchi Seas, belugas would be most sensitive to oil contamination during spring migration (April-June) through open leads. If an oil spill were to happen within the lead system, several thousand whales could be contaminated at once. Multiple spills could cumulatively impact the population and could result in decreased production or population decline. Overall cumulative impact of oil spills on belugas in these areas would range from negligible to moderate. In the Cook Inlet and Gulf of Alaska, belugas may be particularly sensitive at the present low population level to additional environmental stress. Accidental oil spills could be fatal to individuals through direct contact or reduction in prey. Displacement caused by oil spills and cleanups could prevent access to habitat critical to feeding, breeding, or mating. Any reduction in survivorship could push this population towards extinction; thus, cumulative oil spills could have a major impact on the Cook Inlet beluga population.

Killer whales are wide ranging throughout Alaskan waters and are most susceptible to oil spills through ingestion of contaminated prey (Geraci, 1990; Wursig, 1990). Bioaccumulation of toxins could lead to fatalities. Killer whales do not appear to avoid oiled areas, making their risk of contamination high. As tanker traffic and oil development increase, so would the probability and number of oil spills, which cumulatively would result in a higher degree of contamination of killer whales. The effect on killer whale populations is expected to be moderate depending on the location, frequency, and duration of oil spills.

The effects of accidental oil spills on harbor and Dall's porpoises are expected to be similar to those previously described for killer whales. Harbor porpoises inhabit more inshore areas and thus may be more affected by oil spills than Dall's porpoises. An oil spill would most likely displace individuals from the contaminated area for several months. The probability and number of tanker spills in the Gulf of Alaska increases in the cumulative scenario (Table 4-6c), and therefore the probability of contamination to either species. The cumulative effect on harbor and Dall's porpoise populations is expected to be moderate.

Overall, cetaceans exposed to current levels of pollution, noise producing activities, subsistence, commercial fishing activities, shipping, and tankering, and spilled oil over the cumulative scenario time period (35-40 years) would experience some mortality; however, most effects are expected to be nonlethal. None of the nonlethal effects should affect recruitment or distribution of a whale population.

4.8.3.3.2 Pinnipeds

The OCS oil and gas cumulative scenario assumes up to 30 exploration wells, 10 platforms, and 160 development and production wells over the 35 years of activity in Cook Inlet (Table 4-6b). Direct and indirect interactions with activities unrelated to oil and gas will contribute cumulatively to oil and gas activity impacts on pinnipeds.

Six commercial fisheries operating within the range of the western U.S. stock of Steller sea lions were monitored for incidental take by NMFS observers during 1990-1997. The combined mortality estimate from Bering Sea and Gulf of Alaska groundfish trawl and longline fisheries and the Prince William Sound salmon drift gill net fishery resulted in an estimated mean annual mortality rate of 23.7 sea lions per year (Hill and DeMaster, 2000). In addition, from 1990-1997, there was an annual mean of 5.7 mortalities of Steller sea lions attributed to interactions with commercial fishing gear (Hill and DeMaster, 2000). Overall, the minimum estimated mortality rate per year due to interactions with commercial fisheries is 30 sea lions. With the current population decline, cumulative effects of mortalities due to fisheries interactions could significantly impact the sea lion population. Shooting of sea lions by fishermen was also a significant source of mortality. However, this is now illegal.

Walrus interactions with fisheries occur to a small degree but are unlikely to be conservation issues (Sease and Chapman, 1988). A variety of contaminants, including organochlorines, hydrocarbons, and heavy metals, have been identified in walrus tissues (Sease and Chapman, 1988). Past discharge of nuclear wastes into the Bering and Chukchi Seas may affect the benthic marine environment where walrus feed (Schliebe et al., 1995). Coastal developments near new or reestablished terrestrial haul-outs can disturb individuals when suitable haulouts on ice are unavailable.

Commercial fisheries operating within the range of ringed, bearded, spotted, and ribbon seals were monitored by boat-based NMFS observers from 1990 to 1995. No mortalities incidental to observed fisheries were recorded for spotted seals, and small numbers (one to four) were reported for bearded, ringed, and spotted seals (Hill and DeMaster, 1999).

The most significant impact on the northern fur seal was the historic commercial pelt harvest. The population was estimated at approximately 2.1 million in the 1950's (Briggs and Fowler, 1984). The Alaska population was reduced to approximately 1.25 million in 1974 after a female harvest (York and Kozloff, 1987). Currently, the minimum population estimate for the Eastern Pacific stock is 850,000 (Hill and DeMaster, 1999).

Past and current commercial fisheries are responsible for mortalities of northern fur seals. The total number of fur seals killed incidental to both foreign and the joint U.S.-foreign commercial groundfish trawl fisheries in the North Pacific from 1978-1988 was approximately 250, which resulted in an estimated mean annual mortality rate of 22 (Perez and Loughlin, 1991). The foreign high seas drift net fisheries incidentally killed large numbers, with an estimated 5,200 in 1991 (Larntz and Garrott, 1993). However, these fisheries are no longer operative. The current estimated minimum annual mortality rate incidental to commercial fisheries is 2-17 fur seals per year based on observer data, and 15 per year based on self-reported fisheries information (Hill and DeMaster, 1999).

An additional source of mortality in fur seals has been entanglement in marine debris. During the 1970's and early 1980's, entanglement was blamed for contributing to the observed decline in the Pribilof Island fur seal population (Fowler, 1987; Swartzman et al., 1990). Between 1995 and 1997, the entanglement rate of subadult males was 0.2 percent, comparable to the observed rate for 1988-1992 and 1994-1996 (Fowler and Ragen, 1990; Fowler et al., 1994; Robson et al., 1997).

Native communities in the Pribilof Islands harvest subadult male fur seals each year for subsistence use. The NMFS and the tribal governments set the harvest quota for 3-year intervals. The mean annual subsistence take from the Pribilofs between 1994 and 1996 was 1,708 fur seals. The subsistence harvest is the largest known source of direct mortality; however, it does not exceed 10 percent of the potential biological removal level of the population.

Native communities in the Aleutian and Pribilof Islands are the primary subsistence users of Steller sea lions. Mean annual subsistence take from this stock during 1993-95 was 412 sea lions (Wolfe and Mishler, 1996). Currently, there is limited monitoring of sea lion harvests throughout the State, and it is unknown how harvests are affecting local or regional sea lion population growth.

The annual subsistence harvest has the greatest direct anthropogenic impact on the Pacific walrus population and averaged 6,700 individuals in the 1980's (USDOI, FWS, 1994). Fay and Bowlby (1994) reported that the harvest should remain sustainable as long as the composition of catch does not become skewed towards females, there is no large increase in the number or range of small vessels harvesting walruses, and the focus of the harvest remains for traditional subsistence and handicraft purposes.

Native peoples harvest all four species of ice seals throughout their range. Alaskan subsistence hunters in the Bering Strait and Yukon-Kuskokwim regions annually harvested 850-3,600 spotted seals a year during 1966-1976 (Lowry, 1984). Annual harvests in Alaska from 1992 to 1995 were estimated by Wolfe and Mishler (1993, 1994, 1995, 1996) to be 437, 265, 270, and 197 spotted seals, respectively. There does not exist a current reliable estimate of ringed or bearded seals harvested annually for subsistence. However, from 1966 to 1977, there were estimated annual harvests of 1,784 bearded seals by Alaskan subsistence hunters (Burns, 1981b). Between August 1985 and June 1986, 791 bearded seal were harvested in five villages in the Bering Strait region (Kelly, 1988a). While there is no reliable estimate of ribbon seals harvested for subsistence in Alaska, in the mid 1980's the Alaska Eskimo Walrus Commission estimated the subsistence take to be less than 100 ribbon seals per year (Hill and DeMaster, 1999).

Current tourist, recreational, and commercial vessel activity in Cook Inlet and the Gulf of Alaska may disturb sea lions on haulout areas and rookeries. As the human population and tourist activities increase in these areas, so would the frequency and scope of disturbance events. Vessel and aircraft traffic (Table 4-6b) over rookeries and hauling grounds would be the most disruptive to sea lions, and these disturbances would cumulatively increase with additional lease sales. However, these industrial activities would have negligible effects by avoiding critical habitat. Disturbance responses from vessel traffic near shore may affect individuals hauled out on shore, but these effects are expected to be short term and can be mitigated. The satellite launch facility on Kodiak Island would be an additional source of noise disturbance to sea lions. This disturbance would also contribute to the overall cumulative affects of noise, potentially resulting in abandonment of haulout areas or general avoidance behavior. Cumulatively, an increase in vessel traffic could have a moderate negative impact on the population.

Oil and gas development related activities that may cumulatively affect walruses in the Chukchi Sea/Hope Basin Planning Area include dredging, aircraft and vessel traffic, and drilling activities (Table 4-6b). Dredging operations disturb the benthic environment where walruses feed. Impacts should be minor in spatial scale and last for a couple of years. Exposure to low-flying aircraft can cause hauled-out walruses to stampede for open water and crush young pups. Brueggeman et al. (1990b) found that walruses were seemingly unaffected by active drillships if they were stationary or drifting, but usually displayed avoidance reactions to moving vessels that approach within 460 m.

Icebreakers were found to cause the greatest amount of displacement to walruses, sometimes causing avoidance of over 20 km. Walrus returned to their pre-disturbance distribution after ice-breaking activities ceased. Exposure of walruses to drilling operations would be limited to the time when the edge of the ice pack encounters drill sites during its annual recession north in the spring and advancement south in the fall. Impacts on the Pacific walrus population associated with OCS oil and gas development can be avoided with proper mitigation, and should be minor for the duration of projects.

Vessel and aircraft activity is probably the greatest source of disturbance to ice seals throughout the Beaufort and Chukchi Seas. Helicopter traffic to and from offshore oil facilities could displace seals from ice floes. Spotted seals are particularly sensitive to overflights, and respond by moving quickly across floes and diving into the water (Cowles et al., 1981). Erratic diving behavior could lead to mother-pup separation and increased pup mortality. Ringed and bearded seals have also been known to dive into the water when approached by low flying aircraft (Burns and Harbo, 1972; Burns and Frost, 1979; Alliston, 1981; Born et al., 1999; Moulton et al., 2000). Ringed seals would be the species most affected by increased offshore development, as they are the most abundant ice seal species in the Alaska OCS Planning Areas. Cumulatively, additional platforms may displace ringed seals from the surrounding areas. Link et al. (1999) found that ringed seal density in areas of on-ice industrial activities were lower in 1998 than in 1997.

Seismic exploration produces significant noise, which can affect the hearing and locally displace ice seals; however, most ice seals, with the exception of ringed seals, remain with the pack ice far to the north of seismic exploration. Individual ringed seals may be locally displaced by seismic activity, and seismic air gun blasts greater than 190 decibels (dB) at (re) 1 micropascal (μPa) can damage seal hearing. Multiple seismic operations at any given time may cumulatively affect the distribution of ringed seals; however, this effect is expected to be only minor to moderate, depending on the number of operations and the duration and size of each.

It is unlikely that routine operations from oil and gas exploration and development would contribute greatly to cumulative effects on northern fur seals, as northern fur seals are rare and seasonal within the Cook Inlet and Gulf of Alaska Planning Areas. Routine aircraft traffic is expected to be the greatest source of disturbance to fur seals, as this traffic could temporarily displace fur seals from haulout areas. Cumulatively, disturbance from aircraft could potentially displace fur seals, but the effects should be sublethal and negligible at the population level.

Development in the Pribilof Islands has produced the following factors that may cumulatively impact fur seal habitat: increased nearshore discharge of seafood processing waste, oil spills, increased direct human disturbance, and increased levels of noise and olfactory pollution (Hill and DeMaster, 1999). Therefore, increased human development near these critical habitat areas could produce moderate to major impacts to the population.

OCS oil and gas exploration activities, including seismic exploration, may displace harbor seals from the areas in the immediate vicinity of the activity. While disturbance from these separate activities may only affect a few individuals, cumulatively, the subsistence harvest, vessel and aircraft traffic, oil spills, and seismic and other exploratory activities may have a minor to moderate effect at the population level, depending on the frequency, location, and duration of the operations.

Commercial fisheries, subsistence harvest, illegal killing, noise disturbance, and displacement from vessel and aircraft activity cumulatively impact harbor seal populations in Alaska. Increased vessel and aircraft activity related to OCS oil and gas development (Table 4-6b) may contribute to the cumulative effects on harbor seals. Low-flying aircraft has been responsible for mass stampedes exiting haulouts and pupping beaches (Johnson, 1977; Pitcher and Calkins, 1979). Johnson (1977) estimated that low-flying aircraft might have been responsible for more than 10 percent of the mortality of the 2,000 pups born on Tugidak Island, Alaska, in 1976. Minimum overflight altitudes could mitigate impacts from aircraft. Depending on the extent, duration, location, and frequency of these combined activities, the overall impact is expected to range from minor on the regional scale to major on the local scale.

There is no evidence that any of these combined activities significantly affect the population of Pacific walrus, which is considered to be within its range of optimum sustainability (USDOI, FWS, 1994). However, concentrated disturbances in important areas used for mating, calving, rearing, resting, or feeding could have minor to moderate cumulative effects on the walrus population.

An oil spill in Cook Inlet or Gulf of Alaska may contact one or more areas where sea lions are concentrated. An increase in oil and gas development and related tanker traffic in these areas would potentially increase the number of spills and thus the number of sea lions affected. However, Calkins et al. (1994) found no evidence for impacts to Steller sea lions from the *Exxon Valdez* oil spill. Cleanup activities would have a greater potential to cause sea lions to abandon coastal haulout areas and/or rookeries. Accidents and the related cleanup efforts during the pupping season could further negatively impact sea lion production and population growth in an already declining population.

The northeastern Chukchi Sea supports a large proportion of the walrus food resource. The benthic invertebrate population and the thin, nonrenewable, substrate that they occupy are susceptible to oil spills (Nelson et al., 1994). Long-term adverse effects on walrus benthic food resources could include direct mortality, altering of species composition, and lowering productivity (Hansen, 1992). Long-term effects of oil ingestion and hydrocarbon accumulation in cold water marine mammals are uncertain, but could result in high levels of hydrocarbons present in blood when metabolized from blubber (Hansen, 1992). Arctic marine mammals have been exposed to natural crude oil seeps throughout their evolution and appear to be tolerant of moderate amounts of stored toxic hydrocarbons, but artificially high amounts could have serious effects (Hansen, 1992). The assumed OCS oil- and gas-related spills (Table 4-6c) should have negligible to minor impacts on the Pacific walrus population, if the spills were infrequent and small in size or if a spill were to occur in the Beaufort Sea, where walrus may occasionally move in summer. Large pipeline or platform spills in the Chukchi Sea during the summer could have moderate to major cumulative effects on the Pacific walrus population.

Accidental oil spills could detrimentally affect ice seals, haulouts, or major prey species. Pups are more susceptible to oil contamination than adults. Unlike adults, ice seal pups do not have a thick blubber layer. They are insulated with dense underfur until they are several weeks old. This insulating fur could be easily fouled by oil and cause hypothermia in newborn pups, increasing pup mortality. However, ice seals do not congregate in rookeries, so oil contamination from a single spill should not affect large numbers of seals. The number of seals contaminated would increase with additional contaminated areas or spills.

During the winter and spring, ringed seals, in particular, would be most susceptible to an oil spill when the landfast ice restricts their movements. They would be less able to disperse from oil-contaminated areas. In addition, a reduction in prey species due to oil contamination during this time period could reduce survivorship of individuals. Future offshore developments in the Beaufort and Chukchi Seas would increase the probability of an oil spill and the number of seals that would be affected.

Accidental oil spills pose the greatest threat of industry-related impacts to fur seals in Alaskan waters. Due to their highly migratory nature, a large proportion of the individual fur seal population could potentially be exposed to a tanker spill in the Gulf of Alaska. Oil spills contacting the Aleutians during the spring or fall could impact a significant number of migrating seals (Johnson et al., 1989). Large tanker spills from all sources could be a significant source of mortality in fur seals, depending on the location, timing, duration, and size, and the impacts of the spills. Cumulative oil spills would have a more severe impact on individuals than populations, and these effects could be moderate.

The overall cumulative impacts to pinnipeds are expected to be somewhat greater than for whales primarily because of their dependence on coastal areas, which are subject to more human interactions.

4.8.3.3.3 Fissipeds

Introduction of radioactive wastes into arctic marine waters offshore Russia and near Cape Thompson, Alaska (Schliebe et al., 1995) are a matter of concern for polar bears. Hexachlorocyclohexane (a component of pesticides like lindane) levels in arctic marine mammals are the highest in polar bears from the Bering and Chukchi Seas, which reflects continuing input from Asia.

Alaska Native harvests are the largest direct source of mortality on the polar bear population. The majority of the harvest comes from the Chukchi Sea region (Scott et al., 2000). Harvests at this level are considered sustainable (Schliebe and Evans, 1995).

Native harvests of sea otters are capable of limiting local population growth and are regulated at the present time. Forage availability may be affected in local areas where the shellfish harvest is heavily concentrated. Killer whales have been witnessed to regularly take sea otters in areas where the two species historically coexisted. Unforeseen changes in the prey base of killer whales near the Aleutian Islands during the 1990's may be solely responsible for the 70-percent decline of local sea otter stocks (Estes et al., 1998).

Sea otter populations or stocks, are impacted by recreational activity, sewage and industrial effluent discharges, native subsistence harvest, research harassment, forage competition with nearshore shellfisheries, and intentional mortality caused by fishermen. Conflicts with fisheries and subsequent deliberate mortality by humans have been documented for years in Alaska and have increased as the sea otter has repopulated areas with intensive coastal fisheries from the Copper River delta westward through the Aleutian Islands (Rotterman and Simon-Jackson, 1988). Rotterman and Simon-Jackson (1988) infer from other coastal fisheries that direct mortality throughout the State could have a significant effect on sea otter distribution and abundance. However, based on the limited data available, the FWS indicates that sea otter populations in Alaska are not likely to be significantly affected due to commercial fishery interactions.

Lentfer (1990) listed some ways that routine oil and gas activities could affect polar bears. They include death, injury, or harassment as a result of human interactions; damage or destruction of essential habitat; ingesting contaminants, other than accidentally spilled oil; disturbance from industrial noise; harassment by aircraft, ships, or other vehicles; increased hunting pressures; indirect food chain effects; and stress resulting from scientific research. In recent time, three lethal takes related to industrial activities and one at a remote radar defense site on the North Slope have been documented (USDOI, FWS, 2000).

Reactions of polar bears to disturbances caused by vessels and low-flying aircraft are usually brief and range from running and swimming to no reaction (Shideler, 1993). Amstrup (1993) reported that helicopter overflights do not appear to cause female polar bears to abandon their dens, but bears occasionally emerge from their dens when on-ice vehicle traffic passes within a few hundred meters. A prematurely abandoned den would result in lowered cub survival. The majority of polar bears that utilize coastal areas for denning in Alaska are found to den east of 146º W. longitude along the ANWR coastal plain (Amstrup, 1995), where oil and gas exploration has ceased and development has not begun. Amstrup (1995) found that denning polar bears were generally tolerant of research-associated disturbance and indicated that spatial and temporal restrictions on developments could prevent most disruptions of denned bears. Coastal onshore and offshore winter developments related to OCS lease sales could disturb denning polar bears, but the effects on overall recruitment rates should be negligible.

The FWS has not estimated annual mortality of sea otters due to oil and gas development activities including oil spills. Routine operations associated with the cumulative scenario (Table 4-6b) are thought to have negligible impacts on sea otters (Riedman, 1983) and a minor contribution to the cumulative effects at the population level.

Accidental oil spills could potentially affect polar bears by means of direct oiling, oil ingestion, alteration of and displacement from preferred habitat, and change in prey base. Direct oiling causes loss of thermoinsulation and hypothermia. Oritsland et al. (1981) reported the deaths of two captive polar bears after the two bears had been coated with crude oil. The bears licked the oil off their fur and the floor of their enclosure, resulting in kidney failure and a dysfunction in the production of red blood cells. Oil contamination of preferred hunting locations of polar bears would reduce bear fitness by displacing prey and increasing the likelihood of becoming oiled and ingesting oil contaminated prey. Although extensive annual movements of polar bears have been documented within the two regional population ranges, it is expected that only a small portion of the population would be exposed to oil spills in more than one lease sale area.

Assuming proper implementation of oil spill contingency plans, an oil spill in the Beaufort or Chukchi Sea Planning Area should have negligible to minor impacts on polar bear populations in areas of little hunting pressure. However, in areas of greater hunting pressure, such as Barrow or Shishmaref, oil spills could have moderate to major cumulative effects.

Negative impacts caused by large-scale oil spills are the greatest threat to some sea otter stocks in Alaska. The cumulative case scenario includes a 4,600 bbl pipeline spill in Cook Inlet, and two similar pipeline spills and one platform spill (1,500 bbl) in the Chukchi Sea/Hope Basin unit (Table 4-6c). The potential for sea otters to be harmed by oil spills resulting from well blowouts, pipeline breaks, and tanker accidents increases as sea otters recolonize their historic range and the level of oil-related activity rises. It is estimated that 3,905 sea otters died as a result of the 1989 *Exxon Valdez* oil spill (DeGange et al., 1994). The recovery of stocks affected by heavy oiling can take several years, even when the recovery is not limited by continued exposure to residual oil (Holland-Bartels et al., 1997). Ballachey et al. (1994) reported that, by 1993, chronic damages to sea otters from the *Exxon Valdez* oil spill may have been subsiding, and recovery of the affected population was underway.

Proper implementation of oil-spill contingency plans would help mitigate adverse cumulative effects of accidental spills. Depending on the geographic scope, magnitude, and frequency of accidental oil spills and the condition of the sea otter stocks affected, the impacts of cumulative oil spills associated with the development of oil and gas resources could range from negligible to moderate.

***Conclusion*:** The overall impact of routine activities on cetaceans is **minor**. Substantial whale mortality is not expected as a result of spilled oil. If large oil spills were to occur and contact cetaceans, most species would be expected to experience **minor** impacts. The exceptions would be the beluga and killer whales and the harbor and Dall's porpoises that could experience **moderate** impacts at the population level. Also a large oil spill in Cook Inlet could have a **major** impact on the Cook Inlet beluga population. The contribution of the proposed action to the cumulative impacts is expected to be relatively **minor** and short term for whales. The principal components of the impacts to pinnipeds (commercial fishing, subsistence and non-OCS oil and gas operations), could have **moderate** impacts on these populations. Oil spills could have a **moderate to major** impact on pinniped populations. However, as for whales, the incremental impact of the proposed program on pinnipeds is expected to be **minor** or small as compared the principal impacting components. The impact of all routine activities appears to be **negligible** on polar bears and **minor** on sea otters. The overall impact of the oil spills is expected to be no more than **minor** for polar bears and up to **moderate** for sea otters. The cumulative impacts on fissipeds from routine oil and gas development activities should have a **negligible** impact on polar bear and sea otter populations and should make a **minor** contribution to impacts from all the cumulative activities.

4.8.3.4. Terrestrial Mammals

There are various anthropogenic activities that could cumulatively affect the distribution, behavior, and survivorship of terrestrial mammals in habitat adjacent to the Alaska OCS planning areas. These activities include subsistence harvest, sport hunting, mining, logging and other industrial development, oil and gas exploration and development, and oil spills or other accidents related to oil and gas exploration and development.

The cumulative case scenario for all OCS oil and gas activities in Alaska is summarized in Table 4-6b. In contrast to the proposed action alone (Table 4-1b), there is a notable increase, especially in the number of platforms, wells, new shore bases, new pipeline landfalls, and helicopter trips.

Large accidental oil spills (≥ 500 bbl) are assumed to occur in the Alaskan OCS environment under the cumulative case scenario, especially in the Beaufort Sea and Chukchi Sea Planning Areas. The cumulative scenario (including the proposed action) considers pipeline (4,600 bbl) and/or platform (1,500 bbl) spills in the Beaufort Sea, Chukchi Sea, and Cook Inlet, and a tanker spill (7,800 bbl) possibly off the Gulf of Alaska coast (Table 4-6c).

4.8.3.4.1. Caribou and Muskox

The Western Arctic (WAH), Central Arctic (CAH), Teshekpuk Lake (TLH), and Porcupine Caribou (PCH) herds use habitat adjacent to the Beaufort and Chukchi Sea Planning Areas (Figure 3-28). Caribou are typically present during June, July, and August; however, a portion of the WAH and TLH herds remain on the coastal plain through the winter.

Most offshore oil and gas exploration and development, with the exception of the construction of a pipeline from the Chukchi Sea to the TAPS, is expected to have only negligible effects on caribou herds. Pipelines and roads can act as barriers to caribou movements. In the summer, caribou travel to the coast, seeking insect-relief habitat. Without proper mitigation, a pipeline stretching from the Chukchi Sea to the TAPS corridor may restrict caribou's ability to reach the coast. Curatolo and Murphy (1986) found that heavily traveled roads directly adjacent to pipelines impede caribou movements more than roads that were separated from pipelines by at least 100 m. They also confirmed that pipelines elevated greater than 1.5 m facilitate caribou crossing.

Habitat destruction and fragmentation, as well as displacement of caribou from prime habitat areas, can result from oil field development. Direct loss of habitat to gravel placement for pads and roads is small in scale, both temporally and spatially, compared to the area available on the coastal plain and the extent to which it is used by caribou herds on an annual basis. However, during the calving season, from late May to late June, cows with calves are particularly sensitive to human activities. As a result, some cows with calves are locally displaced from onshore oil field infrastructures (Cameron et al., 1992). Additional onshore development would incrementally increase these impacts.

Combined with pre-existing oil field infrastructure, the impact of additional pipelines on caribou movements, if not properly mitigated, could be moderate to major. However, if the following mitigation measures were enforced, onshore facilities and activities associated with the offshore development program in northern Alaska should have minor impacts on caribou herds:

- constructing pipelines at least 100 m from roads;
- elevating pipelines greater than 1.5 m above ground;
- maintaining traffic control in critical habitat areas, such as calving grounds during calving season;
- constructing buried or higher than normal pipelines in areas that are used heavily by caribou; and
- adhering to minimum altitude levels for aircraft traffic.

Impacts of oil field development on muskox inhabiting the arctic coastal plain would generally be similar to impacts on caribou. Muskoxen are present in the arctic planning areas through the winter, making disturbance from winter construction more likely. However, the limited distribution and smaller population size of muskoxen should make the cumulative impact of oil field development minor.

Additional impact to caribou herds on the North Slope of Alaska comes from sport and subsistence hunting. These hunts are managed and monitored by Alaska Department of Fish and Game, and are deemed sustainable at this time. They should have minor impact on individual herds. There is limited subsistence harvest of muskoxen on the North Slope, and the impact on the population is estimated to be minor.

Accidental oil spills from onshore or offshore facilities could impact caribou and muskoxen on the North Slope. The assumed number of large oil spills just from the OCS activity increases for the cumulative scenario (Table 4-6c), in contrast to the proposed action alone (Table 4-1e). It is unlikely that either species would ingest contaminated vegetation, as they are selective grazers. However, oil-spill cleanup activities may displace them from contaminated areas. If animals were directly oiled, they could die from the inhalation of toxic hydrocarbons and/or absorption through the skin (USDOI, MMS, 1996a). Staging and support activities for a large offshore spill during the summer months could displace animals from critical insect-relief habitat. The additional spills would cumulatively increase the magnitude and scope of the impact on caribou and muskox herds. The overall cumulative impacts from accidental spills could range from minor to moderate.

4.8.3.4.2. Arctic Fox

Arctic foxes can become habituated or attracted to human activities related to petroleum development (Urquhart, 1973; Fine, 1980; Eberhardt et al., 1982; Rodrigues et al., 1994) due to increased availability of anthropogenic food sources. Anthropogenic food sources can cause foxes to remain in and around developed areas throughout the winter instead of dispersing, and may increase survival of the young of year and adults (Bannikov, 1970). Increased fox densities caused by human activity increase predation on local natural prey species, such as tundra-nesting shorebirds and waterfowl

(Johnson et al., 1993a,b). Increased fox predation on waterfowl could possibly impact federally listed threatened species, such as the spectacled and Steller's eiders. In addition, increased fox densities near human developments increase the risk of transmission of diseases, such as rabies, canine distemper, and canine hepatitis. Cumulatively, additional oil development, such as increased number of shore bases (Table 4-6b), would increase the likelihood of impacts on fox populations in the Beaufort Sea, and Chukchi Sea, and Hope Basin Planning Areas. Depending on additional infrastructure, the impacts could range from negligible to minor.

Mitigation measures designed to reduce impacts on arctic foxes inhabiting the North Slope oil fields include improved waste management procedures and educating oil field personnel on the danger of human/fox contact. With mitigation, oil development should have only minor effects on fox populations.

Accidental oil spills onshore and offshore could impact arctic foxes through contamination of prey or reduction of prey availability, and fouling of fur. The cumulative case oil-spill scenario (including the proposed action) for the Beaufort Sea and Chukchi Sea Planning Areas includes an increase in assumed OCS large oil spills in the Beaufort Sea Planning Area (Table 4-6c). Because arctic foxes are highly mobile, they have the ability to disperse from oil-spill areas. The greatest impact on foxes would come from ingestion of contaminated prey. They are highly opportunistic feeders, and may readily prey on oiled birds or consume oiled carcasses. The extent of the impact would depend on the frequency, location, and size of oil spills; however, the cumulative impact of oil spills is expected to be only minor.

4.8.3.4.3. Grizzly and Black Bears

Grizzly (brown) and black bear populations adjacent to the OCS planning areas and support facilities are generally considered stable. However, hunting pressure and human disturbance are increasing (Hicks, 1998, 1999). Nearly all relevant bear populations are affected and possibly limited by hunting. Poor salmon escapements resulting from run sizes and commercial fisheries can affect fitness levels of bears that utilize these resources (Sellers, 1998). Logging practices in areas such as coastal Prince William Sound, eastern Gulf of Alaska, and the Kenai Peninsula threaten local bear abundance and distribution by destroying important habitat, providing new road access for legal and illegal hunting, increasing human activity and developments, and increasing human-bear interactions leading to increased bear mortality (McLellan and Shackleton, 1988). These activities could have moderate cumulative effects on local bear populations, requiring several years for recovery.

Improper waste management has affected the bear population occupying the North Slope oil fields by altering the feeding habits of several individuals (Shideler and Hechtel, 2000). However, impacts should diminish as waste management procedures are modified. Aircraft activity can disturb individual bears for short periods of time. Routine operations associated with development of oil and gas resources from the Beaufort Sea, Chukchi Sea, and Hope Basin Planning Areas may have minor impacts on North Slope bears; however, impacts should be negligible to minor elsewhere, having little additional consequence on cumulative effects.

Many grizzly and black bears use the marine coastal environments of the Gulf of Alaska, Prince William Sound, and Cook Inlet, and therefore may be susceptible to accidental oil spills. However, only a limited number of grizzly bears use the OCS coastal area in the arctic. Large oil spills ($\geq$ 500 bbl) are assumed from OCS activities in the cumulative scenario for the Beaufort Sea, Chukchi Sea, and Cook Inlet Basin Planning Areas (platform and pipeline spills), and possibly the Gulf of Alaska (tanker spill) (Table 4-6c). The mortality of a young brown bear feeding on oiled carcasses was documented after the 1989 *Exxon Valdez* accident, but population level impacts were undetectable

(Lewis et al., 1991). Future oil spills associated with development and shipping of OCS oil and gas resources should have minor impacts on stable bear populations, but could have moderate impacts on bear populations that are already compromised by hunting, habitat degradation, and/or other environmental factors.

4.8.3.4.4. River Otters

River otters can be found using intertidal and subtidal habitats adjacent to Cook Inlet and the Gulf of Alaska Planning Areas and are highly adaptable to the presence of human activity. Increased boat traffic associated with OCS activities, as well as that from tourism and the fishing industry, may disturb otters on a short-term basis. These impacts would have negligible to minor cumulative impacts on river otter populations.

Oil spills in the waters of Cook Inlet and the Gulf of Alaska from the cumulative spill scenario (Table 4-6c) could directly impact river otters. These could have moderate impacts on river deltas. A pipeline spill near shore in Cook Inlet or a tanker spill in the Gulf of Alaska that fouled inhabited river deltas could have moderate impacts. Oil in these habitats could contaminate locally important food sources and expose the furbearers to direct oiling and oil ingestion through grooming and consumption of contaminated prey or oiled carrion. River otter populations are expected to recover over a period of several years from such impacts.

4.8.3.4.5. Sitka Black-Tailed Deer

Sitka black-tailed deer occur primarily on the islands and mainland along Prince William Sound, the Kodiak archipelago, and along the Yakutat Bay coast of the Gulf of Alaska Planning Area. Routine operations associated with OCS activities under the cumulative case scenario (Table 4-6b) would result in negligible, if any, impacts on deer in the area because they are beyond the area of OCS onshore routine activities.

There are no studies of direct impacts of spilled oil on Sitka black-tailed deer. If oil were to reach the Yakutat coast in the Gulf of Alaska from a tanker transportation spill, intertidal vegetation would be contaminated. The combination of oil ingestion with vegetation and hydrocarbon absorption through the skin could increase the winter mortality among deer in the Yakutat area (USDOI, MMS, 1995e). This would result in minor to moderate impacts on the population in the area. Under the cumulative case scenario (Table 4-6c), the number of assumed large tanker spills which may occur in the Gulf of Alaska Planning Area is doubled.

The estimated probability of one or more large spills (≥ 500 bbl) occurring from all OCS activities in Alaska under the cumulative case scenario is provided in Table 4-6c. The probability of one or more such spills occurring is estimated as 22-26 percent (Cook Inlet), up to 98 percent (Chukchi Sea), and 95-99 percent (Beaufort Sea). Possible large spills from State oil and gas development and from tankers (Gulf of Alaska) are not considered in these estimates.

Conclusion: With mitigation, the impacts on terrestrial mammals due to routine activities under the cumulative case would be **negligible** to **minor** for caribou and muskox, arctic fox, river otter, and Sitka black-tailed deer; and **moderate** for grizzly bear and black bear. If a large accidental oil spill were to occur and contact the terrestrial mammals, the impacts are expected to be **minor** for arctic fox; **minor** to **moderate** for caribou and muskox, and grizzly and black bear; and **moderate** for river otter and Sitka black-tailed deer. The contribution of the proposed action to the cumulative impact from routine operations is **negligible** (river otter, Sitka black-tailed deer) and more substantial, though still **minor**, for caribou and muskox, arctic fox, and grizzly and black bear. The contribution to the cumulative impact of oil spills from the proposed action is substantial in that impact levels for both scenarios are about the same. However, the likelihood of multiple large spills occurrence due to the proposed action alone is lessened, especially in the Beaufort Sea and in the Gulf of Alaska.

4.8.3.5. Marine and Coastal Birds

Water birds, including sea ducks, dabbling ducks, geese and loons, may be affected over the entire area considered for OCS exploration and production. Sources of non-OCS impacts on water bird populations include those related to subsistence harvest (hunting and egg collecting) and sport hunting, predation, habitat destruction, disturbance caused by recreational activities, commercial fishing, and marine shipping. The effects of these activities on water birds may impact birds on nesting grounds, during molting and staging periods in coastal lagoon systems, and on wintering grounds in the Aleutian Islands, the Gulf of Alaska, and in wintering areas outside of Alaska.

Subsistence harvest (hunting and egg collecting) impacts water birds over all Alaska Planning Areas (Wolf et al., 1990; Wentworth, 1998). Sport hunting in Alaska may impact birds directly in the arctic and subarctic planning areas, and winter sport hunting in the lower 48 States may impact water bird species that breed in the Alaska Planning Areas.

Alaska Native subsistence hunting contaminates eider habitats with lead. Lead poisoning of spectacled eiders (*Somateria fischeri*) from ingestion of spent lead shot has been documented (Franson et al., 1995; Flint et al., 1997; Grand et al., 1998). This may have contributed to the decline of spectacled eiders in the Yukon-Kuskokwim delta breeding area. Waterfowl egg harvest also occurs in the Yukon-Kuskokwim delta (Wentworth, 1998) and other bush communities (Wolfe et al., 1990) and may impact spectacled eiders. Sport hunting of spectacled eiders is illegal, but hunters unfamiliar with eider identification may shoot some birds inadvertently.

Natural predation by peregrine falcons, jaegers, ravens, arctic fox, grizzly bear, and other predators impacts water bird populations over their entire range. Some predators (arctic fox, raven, glaucous gull, grizzly bear) are attracted to oil field facilities by the presence of alternate food sources at dumpsters and solid waste disposal sites. Arctic fox and glaucous gull are attracted to dumpsters and garbage dumps, and are known predators of common eider eggs on barrier island breeding grounds in the Beaufort Sea (Noel and Johnson, in prep.). An increase in the number of predators near oil field facilities may increase predation pressure on spectacled eiders and other bird species (Johnson, 1994). The cumulative effects of increased predation could have major impacts on some water bird species.

Arctic fox predation has affected Aleutian Canada goose (*Branta canadensis leucopareia*) populations on their breeding grounds in the past. On the wintering grounds, continuing habitat management and hunting restrictions have reduced negative cumulative effects. However, activities in agricultural areas may displace some birds from feeding areas, and illegal hunting may impact small numbers of Aleutian Canada geese. Such cumulative effects would be expected to be negligible. Subsistence, fishing, and tourist industry activities are not expected to have adverse effects on the Aleutian Canada goose.

Little relevant data exist regarding cumulative effects, such as entanglement of diving water birds in fishing nets, increased recreational land use and development, or the impacts of pollutants such as PCB’s and pesticides. Entanglement of diving ducks in fishing nets appears to be a minor factor causing losses. Most spectacled eiders winter in the central Bering Sea (Petersen et al., 1999) where they are removed from many cumulative impacts, but where they may become entangled with lost commercial fishing gear (drift nets). However, as noted above, the extent of the effects of net entanglement on spectacled eiders and other marine birds is unknown at this time. Habitat destruction (filling of wetlands) on wintering grounds may also impact water birds, although laws are in place restricting wetland development or requiring mitigation for lost wetlands.

Non-OCS industrial activities or development in coastal areas may add to the cumulative impacts on spectacled eiders. Projects such as the Red Dog Mine may cause noise disturbance, or birds may be temporarily displaced by marine vessel traffic. Coastal developments such as construction of new harbor or port facilities, or renovation of existing facilities may also cause some disturbance/displacement of eiders.

Steller's eiders (*Polysticta stelleri*) would experience impacts from the same types of activities as spectacled eiders, including subsistence hunting and potential contamination of eider habitats with lead shot, egg collecting, illegal shooting, predation, disturbance related to recreational activities, commercial fishing, coastal development projects, and marine shipping.

Sources of cumulative effects on shorebird populations (plovers, sandpipers, dowitchers, and phalaropes) include those related to habitat destruction on wintering grounds in the lower 48 States and Central and South America, and predation. Filling of wetland habitats for land development projects in wintering areas of the United States, and Central and South America impacts shorebird populations on nesting grounds, during molting and staging periods on coastal mudflats, and on wintering grounds. Current laws and regulations for the protection of wetland habitats are in place in the United States, but habitats in Central and South America continue to be developed to accommodate increasing population pressures. The effects of future habitat loss may have major impacts on shorebird populations.

Seabirds (i.e., albatross, shearwaters, storm-petrels, cormorants, alcids, jaegers, gulls, and terns) may be affected over the entire area considered for offshore oil exploration and production. Non-OCS sources of cumulative effects on seabird populations include subsistence hunting and egg collecting, predation, recreational activities, commercial fishing, and marine shipping. Other cumulative effects that may impact seabirds include subsistence harvest of birds and eggs, although the impact on seabirds would probably be less than the impacts of subsistence harvest of waterfowl (Wolfe et al., 1990). Loss of commercial fishing gear (drift nets) may also impact seabirds, although little relevant data exist related to recent seabird entanglement in nets.

Alaskan peregrine falcons (*Falco peregrinus*) winter in areas, particularly in Central and South America, where pesticides containing DDT continue to be used. Habitat loss caused by slash and burn agricultural techniques may also impact peregrines. In spite of these adverse effects, the peregrine population continues to recover and seems stable.

Non-OCS activities that could impact bald eagles (*Haliaeetus leucocephalus*) include habitat destruction related to logging practices, illegal shooting, commercial fishing, incidental oil and fuel spills from fishing boats or other vessels, and pollution. The extent of effects of these activities on bald eagle populations are unknown.

The cumulative scenario (Table 4-6b) represents an increase by a factor of approximately 2 to 2.5 in the number of platforms, exploration and delineation wells; development and production wells; oil production; miles of pipeline; and area of bottom disturbance from platform and pipeline installation in the Beaufort Sea and Cook Inlet. The effects of routine oil exploration and production activities on spectacled eiders associated with the cumulative scenario in the Beaufort Sea are similar to those described in the impact analysis for the proposed action (Section 4.3.3.5). Several disturbance factors noted will occur in winter when water birds are not present in the Beaufort Sea. For example, spectacled eiders would likely not be present during gravel island construction and pipeline placement. Cumulative effects of increases in the release of cuttings and drilling muds probably would have negligible impacts on water birds. Benthic communities that serve as food sources for water birds may be impacted by placement of gravel drilling and production islands in the Beaufort Sea, by drilling platforms in Cook Inlet, and by dredging for subsea pipelines in both the Beaufort Sea and Cook Inlet. Placement of pipelines on terrestrial habitats in the arctic planning areas may impact breeding water birds on the arctic coastal plain. The cumulative impacts are likely to be localized and cause increased displacement and decreased productivity for a few birds adjacent to the disturbances. Such impacts would be considered to be minor. Spectacled eiders are not expected to be at an increased risk due to the effects of cumulative impacts related to oil exploration and production in the Hope Basin, Chukchi Sea, Norton Basin, or Cook Inlet.

In the Beaufort Sea, the cumulative effects of oil exploration and production on Steller's eider are similar to those for the spectacled eider. Densities of Steller's eider are lower than densities of spectacled eider on the arctic coastal plain (Larned et al., 1999), and fewer Steller's eiders would be impacted by routine activities related to oil exploration and production in the Beaufort Sea. In the Chukchi Sea and Hope Basin, the cumulative effects related to oil exploration and development activities are not expected to be greater than the impacts described for these areas in Section 4.3.3.5. Activities related to offshore oil exploration and production are not expected to be near Steller's eider breeding populations (Yukon-Kuskokwim delta, wetlands of the arctic coastal plain and primarily the eastern Russian arctic), and impacts would be considered to be negligible.

The Aleutian Canada goose breeds on the Semidi Islands and islands of the western Aleutians. In the cumulative scenario, increased routine activities related to offshore oil exploration and production would not be expected to impact breeding birds because of their considerable distance from sites where oil exploration and production would occur. The cumulative effects of oil exploration and development on Aleutian Canada geese would be expected to be negligible.

Cumulative effects of routine activities associated with oil exploration and production may impact shorebirds on breeding grounds where pipelines and roads occur on terrestrial habitats on the arctic coastal plain. Impacts associated with installation of pipelines and roads on terrestrial habitats would be expected to be localized and affect a small number of birds. Installation of construction camps may cover a limited amount of nesting habitat, causing temporary or permanent displacement of birds and loss of habitat. Activity at construction camps may impact birds on adjacent tundra by displacing them to other habitats. Noise from low-flying aircraft, construction equipment, and facilities may displace shorebirds. Increased predation pressure from predators attracted to oil field facilities (arctic fox, raven) may also impact shorebirds.

In the Beaufort Sea, the cumulative effects of routine activities related to oil exploration and production would be expected to have minor impacts on seabirds. No large breeding colonies are found in the Beaufort Sea Planning Area, and the most likely species to be affected by increases in activities are gulls and terns. Small numbers of guillemots or other alcids also may be affected. Most of the large seabird colonies are removed from the immediate areas of the oil leases, although some large colonies can be found in the lower Cook Inlet. These birds could potentially be impacted by cumulative effects of routine activities related to oil exploration and production in the lower Cook Inlet. Noise from low-flying aircraft and vessel traffic may temporarily displace some birds from preferred feeding habitats. Drilling muds and cuttings would produce low levels of contamination, and are expected to have a negligible impact on seabirds. Seabirds are primarily fish eaters, and the cumulative effects of subsea pipelines and the installation of drilling platforms would be expected to be negligible.

Other factors (e.g., noise from shipping traffic and aircraft, commercial fishing operations, ingestion of floating materials, such as plastic, styrofoam, or other materials), may also impact short-tailed albatross. Some of these factors may occur on the open seas outside the planning area, or on the breeding grounds. Because of the rare status of short-tailed albatross in the planning area, the effects of cumulative impacts would be expected to be negligible.

Cumulative effects of disturbances related to offshore oil exploration and production are expected to have little effect on the two Alaskan subspecies of peregrine falcon because primary areas of falcon activity generally are not near the areas for oil field activities. Disturbances related to onshore oil field activities may have the greatest impacts on peregrine falcons, but only short term disturbances are expected. Such disturbances include noise from aircraft and facilities, and displacement during construction and maintenance activities. Such disturbances would be considered to be minor.

Cumulative impacts to bald eagles related to routine activities of offshore oil exploration and production would be expected to be minor. Activities such as noise from onshore facilities and aircraft, and construction and maintenance activities may disturb birds, causing abandonment of nest sites or temporary displacement from feeding areas.

An oil spill could have major impacts on water birds in both the arctic and subarctic planning areas. The severity of the impacts would be related to the size, location, and timing of the spill, the type of spill material (crude oil, gasoline, diesel, etc.), wind and currents, and spill cleanup capabilities. Negative impacts to water birds from an oil spill in the arctic planning areas would be confined to the summer breeding season and the fall molting and staging periods when birds are present. However, a large spill could impact water bird populations for more than a year if mortality was high for a large number of birds, or if contaminated habitats required a lengthy time period for recovery. Water birds are present year-round in the subarctic planning areas and could be impacted by an oil spill at any time of the year.

There is also an increased possibility of an oil spill that may impact water birds on breeding grounds of the arctic coastal plain or on coastal lagoons and bays during spring and fall molting, staging, and migration. The cumulative effects of disturbance from increased tanker activity along shipping lanes from Valdez to west coast ports, or from a tanker spill may also increase the potential to negatively impact water birds.

There is an increased potential for an oil spill that could impact spectacled eiders on breeding grounds of the arctic coastal plain, or on coastal lagoons and bays during spring and fall molting, staging, and migration.

Fuel spills from fishing boats or other vessels, or a spill from fuel storage facilities on land may impact spectacled eiders. Heavier products such as crude oil may have a greater impact on eiders than more refined products such as gasoline, kerosene, and diesel fuel that dissipate much faster in the environment. The effects of current levels of hydrocarbon accumulation in the food chain are unknown.

The greatest threat to negatively impact spectacled eiders is from an offshore spill at a production site or pipeline in the Chukchi Sea. A tanker spill could have a negative impact on spectacled eiders on coastal lagoons and bays during spring and fall molting, staging, and migration. Nesting habitat is also not likely to be impacted by an oil spill, although a pipeline spill or other type of fuel spill on terrestrial habitats may impact eiders in localized areas.

Cumulative effects include potential oil or fuel spills from commercial fishing boats or other marine vessels, or from onshore fuel facilities that could impact Steller's eiders. The extent of impacts would be related to the size and location of the spill, type of spill material, time of year, wind and currents, and cleanup capabilities.

A large oil spill in the lower Cook Inlet that moved through the Shelikof Strait could impact Aleutian Canada goose breeding grounds on Semidi Island. The migration route of the Aleutian Canada goose is thought to be directly from breeding grounds over open ocean to Oregon and California. A tanker spill along this route would be unlikely to impact many birds, but those coming in contact with oil would suffer high mortality.

The cumulative scenario increases the potential for an offshore oil spill that could contaminate strategic mudflats and other coastal habitats. Shorebirds could be affected directly by coming into contact with oil or by ingesting contaminated invertebrate food sources. The greatest potential to negatively impact shorebirds populations would occur during spring and fall migration, when large numbers of birds congregate on coastal mudflats. Some important areas used by shorebirds during migration include the Copper River delta, Kachemak Bay, western Cook Inlet, and the Stikine River delta. Major impacts to shorebirds could occur in these areas.

The severity of impacts to shorebirds from an oil spill would be related to the size and location of the spill, wind and currents, the type of contaminant, time of year, and cleanup capabilities. The impacts of an onshore spill from a pipeline or other source would be expected to be localized and affect a relatively small number of birds.

The cumulative scenario increases the potential for an oil spill in the Beaufort Sea (and in the Gulf of Alaska along transportation routes for tankers and barges from production sites to west coast ports). An offshore oil spill in the Beaufort Sea could impact gulls and terns, guillemots, and small numbers of other alcids. An offshore spill in the subarctic planning areas could impact shearwaters, puffins and other alcids, storm-petrels, gulls and terns, and other seabirds in the lower Cook Inlet, Kodiak Island, Prince William Sound, and the Gulf of Alaska. Oil from a spill may come in contact with seabirds directly, causing hypothermia or drowning, or may contaminate food sources. The extent of the impact would depend on the location, size, and timing of the spill, wind and currents, the type of spill material, and the cleanup capabilities of the oil industry and local agencies. Seabirds may also be affected by oil or fuel spills from fishing boats and other marine vessels, or by a spill from fuel storage tanks on land.

Short-tailed albatross is a pelagic species that occurs rarely in the offshore oil leasing area. Cumulative effects of activities related to offshore oil and gas leasing that could potentially affect short-tailed albatross occur in the Gulf of Alaska and are related to increased tanker and barge traffic to transport crude oil from Valdez and Cook Inlet to west coast ports. An oil spill from a tanker or barge that occurred on the open seas, or incidental oil and/or fuel spills from fishing boats or other marine vessels, could potentially impact individual short-tailed albatross.

In the cumulative scenario, an increase in potential for an offshore oil spill from a tanker or barge could increase the potential to impact individual peregrine falcons in coastal habitats. Peregrines could come in direct contact with oil from a spill by standing in contaminated shoreline areas or mudflats. Ingestion of oil may occur if falcons were feeding on oiled waterfowl or shorebirds, and peregrines could be affected by contaminated food sources or by a reduction in availability of prey species. Cumulative effects related to offshore oil exploration and production that may occur in the Cook Inlet and Beaufort Sea would be expected to be minor.

Bald eagles may be at a slightly higher risk from cumulative effects of an oil spill in Cook Inlet, where the cumulative scenario calls for increases in the numbers of platforms, exploration and delineation wells, development and production wells, oil production, miles of pipeline, and area of bottom disturbance from platform and pipeline installation (Table 4-6b). In addition, tanker transportation of future arctic OCS oil from the TAPS may represent an increased potential for an oil spill that could impact bald eagles in Prince William Sound, the Gulf of Alaska, and the eastern Pacific coast. The effects of an oil spill would likely be more severe on bald eagles than on other raptors because eagles spend more time in coastal habitats and frequently land on coastal shorelines and mudflats, thus increasing the likelihood of coming into direct contact with oil. Eagles are primarily fish and carrion eaters and could be affected by ingestion of oil through contaminated food sources. An oil spill could also alter the distribution and abundance of prey species. Impacts to bald eagles populations from an oil spill would depend on the location and size of the spill, type of spill material, wind and currents, and cleanup capabilities. A massive oil spill could impact bald eagles for a lengthy period of time and require several generations for recovery. The increased cumulative effects to bald eagles from offshore oil exploration and production could be negligible, although a large oil spill could have moderate to major impacts on bald eagles.

Conclusion: Overall, marine and coastal birds that continue to be exposed to current levels of subsistence, predation, pollution, commercial fishing activities, coastal development, habitat destruction, shipping and tankering, and spilled oil over the cumulative scenario time period (20-40 years) could be disturbed or displaced. Some mortality is expected; however, most effects would likely be **negligible to minor**. None of the nonlethal effects should affect recruitment or distribution of a marine or coastal bird population. Increased predation could have a **major** impact on some water bird species. Should a large oil spill contact areas where water birds, shorebirds, or seabirds congregate to breed, nest, molt, feed, or stage for migration, substantial mortality is expected. The result of substantial mortality from a large oil spill would have **moderate to major** impacts on marine and coastal birds. The contribution of the proposed action to the cumulative scenario is expected to be relatively **minor** for marine and coastal birds.

4.8.3.6. Fish Resources

The increase in OCS activity that would occur under the cumulative case would include an increase in the number of seismic surveys and wells. Effects to fishes from seismic surveys and exploratory wells are considered negligible because of the localized and seasonal nature of those activities, with the most acute effects apparent in eggs, larvae and young-of the-year fish. Effects would continue to be negligible, provided additional exploration and development did not occur in sensitive biological habitats or at sensitive times of the year.

Environmental impacts associated with the building, operation, and removal of OCS facilities would increase in conjunction with the increased number of wells and pipelines (Table 4-6b). One of the most critical of these activities would likely be the construction of artificial islands in arctic regions. Artificial islands result in a direct loss of benthic habitat and a temporary increase in turbidity during construction by disturbing the benthos and increasing the suspended sediment load, and they can increase the release of disturbed sediment hydrocarbons and heavy metals. The effect of habitat loss would be acute and lethal to the benthic community, but would be extremely localized within the footprint of the island. The degree of habitat loss would be virtually negligible to finfishes and shellfishes. Although increased turbidity can impede photosynthesis and interfere with primary production, the effect would also be localized and generally limited to the period of construction. The suspension of inert natural contaminants into the water column could bioaccumulate in the food chain; however, the long-term effects are unknown and difficult to gauge for the cumulative case.

Any increase in turbidity or the release of natural contaminants would be considered sublethal and chronic, but only during the periods of island construction and removal. Provided that construction does not occur in environmentally sensitive areas, the overall cumulative effect of island construction to finfishes and shellfishes would be moderate due to island construction, but minor once construction activities have ceased. Regulations and mitigating measures should preclude construction in environmentally sensitive areas.

Effects on fish resources from dredging and marine disposal activities are expected to be similar to those described for the installation of pipelines. Due to the small number of disposal sites and their limited use, these effects are expected to be negligible.

Extensive logging in the Tongass National Forest in southeastern Alaska has degraded riverine habitat that is critical for salmon reproduction and the rearing of juveniles. Erosion from commercial logging increases the silt load in streams and rivers. Increased sedimentation can reduce levels of invertebrate prey species and can adversely affect spawning success and egg survival. The introduction of fine materials into spawning gravels can render these habitats unsuitable for salmon spawning. Logging also removes riparian canopy, which increases solar heating of freshwater habitats. Downed timber can physically block salmon migrations. Because of past damage inflicted by commercial logging, improved forestry practices have been initiated, and timber harvests have been curtailed. Effective forest management should help mitigate the adverse effects of logging in the future.

The Red Dog Mine in Alaska is the largest lead and zinc mine in the world and is presently the only base-metal lode mine operating in northwest Alaska. It is located 87 km from the Chukchi Sea coast, and the seaport for the mine is located approximately 27 km southeast of Kivalina. The port facility consists of a dock and causeway 40 m wide and 60 m long extending out to a water depth of 4 m. Although the presence of causeways has been a major issue associated with oil development activities in the Beaufort Sea, the small size of the Red Dog causeway would likely have little effect on the coastal movements and distributions of Chukchi Sea finfishes and shellfishes. This is particularly true for highly mobile salmonid species that are of economic and subsistence importance to the region.

The increased amount of drilling under the OCS cumulative case would result in an increase in the discharge of drill muds, cuttings, and produced waters (Table 4-6b). Drilling discharges contain materials toxic to finfishes and shellfishes and directly disrupt benthic habitat important to both. Toxic components such as metals and hydrocarbons can bioaccumulate through the food chain. Overall, adverse effects on salmon, groundfishes, shellfishes, and other finfishes in Alaska are expected to be minimal because the area affected by drilling discharges is small relative to the distribution of these species and discharges are regulated by the USEPA to mitigate impacts. Toxic components are rapidly dissipated, and concentrations that are considered injurious to finfishes and shellfishes are typically not found farther than 100 m from the discharge point. Soluble components including saline formation waters rapidly dilute in open water. The benthic disturbance from the insoluble components of drilling discharges is also limited to the area around the discharge point. At worst, only a tiny fraction of finfish and shellfish populations would be affected by drilling discharges.

Recent tests of cruise ship effluents in southeast and south-central Alaska have detected illegally high concentrations of fecal coliform, organochlorines, heavy metals, and other potentially toxic compounds. These findings have sparked increased demands for programs that regularly monitor waste water and bilge water discharge from cruise ships. Contaminants in the effluents from cruise ships may have an effect on fisheries by increasing the biochemical oxygen demand and reducing the amount of oxygen available in the water column. Suspended solids in effluents may settle on the bottom, smothering bottom incubating eggs (Alaska Department of Environmental Conservation, Division of Statewide Public Service, 2001). Although the Alaska Department of Environmental Conservation is urging the cruise ship industry to voluntarily control pollution discharge, mandatory testing by State regulatory agencies has not been implemented.

The total number of oil spills and the extent of affected environment would increase in conjunction with increased levels of petroleum exploration and production. (Table 4-6c) The location and timing of an oil spill would determine any adverse effect to Pacific salmon in the Gulf of Alaska and Cook Inlet. The greatest potential for damage to salmon stocks would be if a spill were to occur along migration routes, but because of the limited area affected by even large oil spills relative to the wide pelagic distribution and highly mobile migratory patterns of salmonids, most impacts would be limited to a small fraction of the population. Oil spills occurring at constrictions in migration routes such as Unimak Pass would have an increased potential for adversely affecting salmon. However, the weathering and dispersal of the spilled oil would limit the length of time that the area would be affected. Pacific salmon are also able to detect and avoid oil spills in marine waters (Weber et al., 1981; Dames & Moore, 1990), which would also help to reduce contact. Salmon aggregates in marine waters also consist of mixed stocks, so even in the unlikely event of contact with an oil spill, only a small fraction of any unique spawning population would be adversely affected.

Adverse effects of oil spills to groundfishes of southern Alaska would also be a function of location and timing. Adult groundfishes are primarily demersal and would only be subject to the insoluble oil and water-soluble fractions of oil that reach deeper strata. Insoluble oil fractions would sink to the bottom and be distributed diffusely as tar balls over a wide area, and would not likely have a serious adverse affect on adult groundfishes. Egg and larval stages would risk greater exposure to oil spills. Spawning aggregations of some economically important groundfish species (such as walleye pollock) lay pelagic eggs that could come into contact with surface oil slicks. Herring are also susceptible at different life stages because they spawn in nearshore waters for protracted periods of time. Despite the added vulnerability of some egg and larval stages, oil spills are not expected to severely affect finfish populations because the total number and the area affected are small. Impacts are expected to be minor.

Commercial shellfish stocks of subarctic Alaska are at historically low levels. While some species, like tanner and snow crab, occur over much of the southern Alaska region, the red king crab occurs in aggregates in lower Cook Inlet and off Kodiak Island. Because adult crab are benthic, they would not be exposed to surface oil. Crabs could be exposed to soluble and insoluble fractions that reach deeper strata, but, as with groundfishes, these components would be distributed diffusely over wide areas and would likely not constitute a threat to crab stocks. Pelagic crab larvae could be affected by surface oil during the spring spawning season, but again the limited area affected by spills is not expected to have a substantial effect on populations.

Arctic finfishes could be susceptible to adverse effects of oil spills. Offshore spills would have little impact, since they would be localized relative to the broad distributions of most marine and anadromous fishes of the Beaufort and Chukchi Seas. Some anadromous species of the Alaskan North Slope could be at greater risk because of their unique life-history cycles. Juveniles of some species of whitefish (including broad whitefish, humpback whitefish, and least cisco) exhibit an intolerance for highly saline marine conditions. During their summer feeding dispersals in the Beaufort Sea, these species tend to remain within a narrow band of warm, low-salinity water that hugs the coast. Offshore barrier islands offer additional protection by helping to maintain low-salinity corridors. Thus, unlike most subarctic fishes, North Slope whitefish do not have the capacity to bypass localized disruptions to their migration corridor by moving offshore and around the impasse. An oil spill, even one of limited area, could block the narrow nearshore corridor and prevent fishes from either dispersing along the coast to feed or returning to their overwintering grounds in North Slope rivers. If a spill were localized in the sensitive nearshore zone, its very location would make it more amenable to cleanup by environmental response teams. There is no tanker traffic on the North Slope, which eliminates the possibility of a collision spill.

Conclusion: The cumulative impacts to fish resources in the Alaska Region from routine OCS and non-OCS activities are expected to be **minor**. The cumulative impact from large spills of Federal OCS and State oil is expected to be **minor** to **moderate**, depending on the location and timing of the spills. The incremental impact from routine activities and oil spills from the 2002 OCS Program are expected to be **negligible** to **minor**.

4.8.3.7. Coastal Habitats

Cumulative impacts from routine activities on coastal habitats (including intertidal benthic communities) in the arctic planning areas include past development of the distant early warning (DEW) Line Stations, mining activities in the Hope Basin, and onshore and offshore oil and gas exploration and development. The routine operations associated with the OCS cumulative case scenario is presented in Table 4-6b. Seventeen DEW Line Stations were constructed along the arctic coast from Point Hope (Chukchi Sea coast) to Point Barrow and to Demarcation Bay on the Canadian border (Beaufort Sea coast). Construction of these stations involved fill placement in wetlands and localized alteration of coastal vegetation. Similarly, port facilities constructed for the Red Dog Mine located onshore in the Hope Basin Planning Area has had localized impacts on adjacent wetland habitats.

Oil and gas exploration and development centered in the Prudhoe Bay area has impacted coastal habitats through construction of roads, gravel pads, pipelines, pipeline landfalls, causeways, and gravel mining sites. Impacts from gravel placement include destruction of vegetation and benthic habitat directly, as well as alteration of plant communities by dust, thermokarst (area depression), changes in drainage patterns, and formation of water impoundments. Development of new North Slope oil fields under currently held leases in the Prudhoe Bay area, at Point Thomson, Liberty, Northstar, and Alpine, along with exploration and potential future development in the NPR-A would add incrementally to the impacts of gravel placement on vegetation and wetlands. Most new developments have a substantially reduced footprint and are often roadless (or nearly so), markedly reducing the impacts of gravel placement on vegetation and wetlands and reducing the number of gravel mine sites required for development. Further development under the proposed action would also contribute incrementally to these impacts.

Similarly, an incremental increase in gravel placement would lead to increases in dust associated with roads and pads. Within 10 m of roads and pads, dust and gravel may smother vegetation, resulting in a shift to weedy species and reduced plant photosynthesis; decreases in some common moss, lichen, and shrub species; and development of barren areas (Walker and Everett, 1987; Walker et al., 1987a; Auerbach et al., 1997).

Construction of roads, pads, and other facilities would cause changes in the natural drainage patterns of some areas and would cause the drying up of some areas due to the restriction of sheet drainage flow volume or duration, and also flooding of some wetlands. These impacts are typically site-specific and are greatly decreased in magnitude by careful siting of roads and facilities, but additive cumulative effects are likely with new developments. Residual ice (late melting) along ice roads or ice pads also influence drainage and affect tundra vegetation. Winter construction employs temporary ice roads and pads to avoid fill placement on vegetation and wetlands underlain by permafrost soils. The slower melting of the ice relative to adjacent tundra decreases the growing season for plants beneath the ice road or pad. Additionally, when the ice used for these structures melts during spring, water temporarily accumulates along the melting edges. In general, these effects have not been identified as a significant drawback to winter construction, because of the mitigative advantages afforded by this construction technique. The North Slope producers use winter construction to build exploratory roads and well pads, to expand existing oil fields, and to develop new satellite fields. However, any temporary adverse effects of late melt out or meltwater on vegetation would be greatly offset by the advantage of avoiding gravel fill. Effects of a shorter growing season would typically last only for that year and would have no long-term or cumulative impacts. Because most of the affected microsites would be perennially wet environments, the additional meltwater would have minor effects and would not persist beyond a single season.

In heavily developed portions of the Prudhoe Bay oil field, thermokarst has resulted from impoundments and construction-related disturbances. Walker et al. (1986) indicated that 3 percent of the total area was affected and that the area of impact was increasing with time. Walker et al. (1987b) suggested that a cumulative loss of habitat was occurring from thermokarst related impacts. Thermokarst in the heavily developed portions of the North Slope oil fields would continue to increase. New developments are designed with minimal footprints, are often roadless, and carefully consider drainage patterns in facility siting. These design improvements have generally been successful at limiting the area impacted by thermokarst. However, additional developments on the North Slope would contribute incrementally to the area already impacted by thermokarst, but the impacts would be substantially less than in the early development of the Prudhoe Bay oil field.

Intertidal benthic habitats have been disturbed by causeway and pipeline landfall construction for oil and gas exploration and development, and by dredging and offshore mining activities. The proposed action would contribute incrementally to these impacts by causing additional localized impacts associated with construction and decommissioning of facilities and pipelines. Pipeline landfalls may require short causeways that would cover benthic habitats in the immediate area, resulting in the loss of that habitat. The presence of these causeways may affect local currents and salinity that may, in turn, affect benthic communities. These impacts would be cumulative with other causeways already in place, but would impact a relatively small total area within the arctic planning areas.

Drilling muds and cuttings produced at drilling and production sites become diluted shortly after they enter the environment in offshore areas. No negative impacts are expected to result in the intertidal benthic habitats from these discharges.

Overall, the cumulative impacts to coastal wetlands and estuaries in the arctic planning areas would be moderate in areas that are developed. Most of the impacts would result from expansion of current developments and new areas in the NPR-A that would expand the geographic scope of oil field impacts. Despite this expansion, the total habitat area impacted is small compared to the total area of available habitat. The action in the OCS planning area would contribute incrementally to these impacts in a minor way, since most development associated with the action would occur offshore. Overall, the cumulative impacts on the benthic communities in the arctic planning areas would be minor. Impacts would be site specific and would impact a small additional amount of the total area of these habitats.

Impacts in the subarctic planning areas would be limited since most OCS activities would occur offshore and would have only a small onshore component. The increase in new pipelines and bottom area disturbed (Table 4-6b) by OCS activities would contribute to a limited disturbance of intertidal habitat in the Cook Inlet Planning Area. Erosion associated with logging in the Tongass National Forest has impacted watersheds and nearshore marine habitat in some coastal areas. Municipal wastes and other effluents, including those from cruise ships, contribute to the cumulative impact on coastal habitat.

In terms of accidental events causing impacts, the oil, fuel, and other chemical spills reported in the North Slope oil fields have generally been confined to the workpad and were small product leaks. However, some larger spills have also occurred. Recently, a pipeline ruptured in the North Slope's Kuparuk field onshore, spilling hot produced water (mostly salt water with some crude oil) affecting less than an acre of tundra habitat (Spiess, 2001). This spill was due to pipeline corrosion; although most of the spilled produced water was recovered within 24 hours, the crude oil coated some vegetation, and the salt water may have seeped into the ground, possibly killing tundra vegetation. Future arctic development (Beaufort Sea, Chukchi Sea/Hope Basin Planning Areas) would also contribute to the cumulative impacts of oil, fuel, and other chemical spills. Tundra vegetation may be exposed to oil in the event of a pipeline leak or a leak or blowout at the production pads or facilities. In addition, coastal wetlands or salt marsh habitats adjacent to these areas could be affected by an offshore spill that reaches the shoreline, or leaks in subsea pipelines traversing the nearshore environment and at pipeline landfalls (Table 4-6c). For pipelines, small spills would most likely be contained on the gravel pads. Leaks in the elevated portion of a pipeline could expose the vegetation to oil. During winter, these would be on top of snow and would be cleaned with minimal impact to tundra vegetation. Spills occurring during summer would penetrate the tundra mat, killing the vegetation, but oil would not penetrate beyond the active layer. Hundreds of oil or other chemical spills have hit the ground on the North Slope oil fields each year; however, most of these were less than 10 gallons (0.2 bbl) (Spiess, 2001), and there is no reason to expect that this would change with future developments. Future development in the arctic area would cause an incremental increase in the impacts of spilled oil on vegetation and wetlands.

Oil exploration and development in the subarctic region (Cook Inlet) may also produce accidental spills that impact coastal habitats. These impacts would primarily be from offshore spills that enter estuaries and nearshore environments rather than from direct leakage onto vegetation. However, leaks at pipeline landfalls are possible and could directly affect oil vegetation. Cleaning of oiled areas is generally more difficult in the subarctic since oil can penetrate more deeply into the ground. Exploration and production of oil in Cook Inlet and transport of oil by tanker through the Gulf of Alaska increases the cumulative total number and volume of oil spills and would increase the likelihood of oil spill impacts in coastal areas. Impacts depend largely on the frequency, size, and location of the spills and are likely to have minor to moderate impacts on coastal habitats in the arctic and subarctic regions.

The estimated probability of one or more large spills ($\geq$ 500 bbl) occurring from all OCS activities in the cumulative case is provided in Table 4-6c. The probability of one or more spills occurring is estimated as 22-26 percent (Cook Inlet), up to 98 percent (Chukchi Sea), and 95-99 percent (Beaufort Sea). Possible large spills from State oil and gas development and from tankers (Gulf of Alaska) are not considered in these estimates.

Conclusion: Impacts to coastal habitats under the cumulative case would be **minor** to **moderate** for routine operations. If large oil spills were to occur and contact the coast, they would likely result in **minor** to **moderate** impacts, which would be dependent on size, location, and timing of the spillage. The contribution of the proposed action to the cumulative impact from routine operations would be very small in the subarctic and more substantial in the arctic, though the overall impact would still **minor** to **moderate**. The contribution from oil spills to the cumulative impact from the proposed action would be substantial in that impact levels (**minor** to **moderate**) for both scenarios would be about the same. However, the likelihood of the occurrence of multiple large spills would be considered less for the proposed action alone, especially in the Beaufort Sea and the Gulf of Alaska.

4.8.3.8. Seafloor Habitats

Routine activities associated with oil and gas development in the Alaska Region may have a cumulative effect on seafloor habitat and benthic communities. These activities include discharge of drill fluids and cuttings, construction, trenching, and maintenance associated with Federal and State lease activities. All of these activities increase turbidity, sedimentation, and burial – threats to seafloor habitats and their benthic communities (see Section 4.3.3.8).

As described in the cumulative scenario (Table 4-6b), the number of platforms (or gravel islands) would increase compared to those in the proposed action (Table 4-1b): an additional two to six platforms or gravel islands would be constructed in the Beaufort Sea and two to four platforms in Cook Inlet, disturbing up to an additional 6-18 ha in the Beaufort Sea and 4-8 ha in Cook Inlet. Platform construction would destroy the existing benthic communities at each site. Recolonization by biota preferring a hard substrate in the area affected by platform construction would alter the biodiversity and distribution of organisms at these locations. Benthic invertebrates and plants needing a hard substrate are expected to colonize platforms within 1 or 2 years. The bottom area disturbed by pipeline construction in the cumulative scenario would increase in the Beaufort Sea by 25-40 ha and in Cook Inlet by 22-75 ha. Again, the habitat in the immediate area would be destroyed and then recolonized. Immobile benthic communities affected by pipeline construction are expected to recover in less than 3 years (USDOI, MMS, 1996a).

Under the cumulative scenario, drilling muds would be approximately 545 bbl/well of fluids in the Beaufort Sea and 655 bbl/well in Cook Inlet, and 4,070 bbl/well of cuttings in the Beaufort and 2,875 bbl/well in Cook Inlet (Table 4-6b). Drilling discharges are estimated to have limited effects on benthic flora and fauna in close vicinity to and down current from the discharge. Turbidity and sedimentation caused by the discharges would kill some organisms, but most affected benthic organisms would experience sublethal effects. Considering the expanse of both of the lease areas, the overall impact of the disruption caused by additional routine activities described in the cumulative scenario would be minor. Areas of construction should recover relatively quickly compared to areas exposed to drilling discharges over time. Because oil and gas development in the Chukchi Sea and Hope Basin is nonexistent, the small amount of potential development in those lease areas would have negligible impact.

Development of State leases could involve construction of platforms, pipelines, and gravel islands that would all contribute to sedimentation and turbidity. Few prospects are likely to be brought on line soon—the most likely being the Northstar prospect in the Beaufort Sea and the Redoubt Shoal prospect in Cook Inlet. Development of these prospects would not significantly impact cumulative effects on seafloor habitat and benthic communities.

The Red Dog Mine on the coast of the Chukchi Sea and vessel traffic for shipping ore are sources of effluents that can be harmful to the seafloor habitat and benthic communities. However, the scope of impact from Red Dog Mine activities would be limited to the area around the mine, and ore production should create a negligible addition to cumulative effects in the area. Increased cruise ship traffic through the Gulf of Alaska is an additional source of effluents that could be injurious to seafloor habitat and benthic communities. It is unlikely that cruise ship traffic would augment enough to cause an appreciable difference in impact to seafloor habitat and benthic communities.

The kelp bed communities of the Stefansson Sound Boulder Patch, situated in the central portion of the Beaufort Sea Planning Area, would be vulnerable because of their restricted distribution (see

Section 4.3.3.8). Drilling discharges close to the beds could cause sedimentation and turbidity, affecting reproduction and recruitment there. Impact level could range from negligible to major, depending on the proximity of development. Long-term effects on the abundance and diversity of the Boulder Patch benthic invertebrates are possible, depending on the duration and area of impact. Effects from development in the OCS are expected to have little impact on the Boulder Patch biota. Impacts are expected to be negligible to moderate.

Large oil spills, if they were to occur, could seriously impact seafloor habitat and benthic communities in the Alaska Region (see Section 4.3.3.8). The effects of oil on benthic organisms could range from discrete and sublethal to lethal. Estimates of recovery time for directly impacted benthic communities would range from 3 to 10 years (USDOI, MMS, 1996a,d). Damage caused by oil contamination would depend on the size and duration of the spill, time of year, and density of biota. Multiple spills would further contribute to cumulative effects. Cumulative effects on the seafloor habitat and benthic biota due to accidental oil spills would range from negligible to moderate, depending on the location and scope of spills.

Conclusion: The overall impact to seafloor habitats of additional routine activities described in the cumulative scenario would be **minor.** Cumulative effects on the seafloor habitat and benthic biota due to oil spills would range from **negligible** to **moderate**, depending on the scope of the spill. The incremental impacts of routine activities assumed under the proposed action to seafloor habitats would be **minor,** and incremental impacts assumed under the proposed action for large oil spills would be **negligible** to **moderate**.

4.8.3.9. Areas of Special Concern

4.8.3.9.1. Essential Fish Habitat

There are several activities that may have a cumulative impact on EFH in Alaska. These activities include oil and gas activities in OCS and State water as well as activities not related to oil and gas.

The EFH for many species includes the benthic environment, such as the mud and sand bottoms along the inner and middle continental shelf. This is also the case for EFH for forage fish, which are prey species for many marine mammals, sea birds, and commercially important fish species.

Oil and gas development operations that could affect benthic EFH are activities that create turbidity, sedimentation, and burial, such as discharges of drilling fluids and cuttings, pipeline dredging, construction, and drilling. As described in the cumulative scenario (Table 4-6b), the number of platforms (or gravel islands), amount of bottom area disturbed, and drilling discharges are projected to increase with the addition of the proposed action.

Benthic EFH in the immediate vicinity of construction and pipeline trenching would be destroyed. Considering the amount of oil and gas activity estimated over a 40-year period in the cumulative case (Table 4-6b), only a very small portion of the benthic environment offshore Alaska is likely to be disturbed. Eventually, the areas disturbed by pipeline and platform installation activities (Table 4-6b) would recolonize; immobile benthic communities are expected to recover in less than 3 years (USDOI, MMS, 1996a).

Under the cumulative scenario, drilling discharges would increase in both rate and duration (Table 4-6b). The area affected by drilling discharges is limited to proximity to the discharge and location down current from discharge. Some species composition changes are expected within 1,000 m of drilling discharges (USDOI, MMS, 1995b). Deposition of drilling fluids and cuttings can smother benthic prey and cover HAPC's including nearshore areas of intertidal and submerged vegetation, rock, macroalgae and kelp. Changes in particle size of the benthic substrate may provide better habitat for some benthic species but unsuitable habitat for others. This could reduce the ability of some managed species to survive and reproduce.

The HAPC's include all anadromous streams, lakes, and other freshwater areas used by Pacific salmon and other anadromous fish, especially in urban areas and in other areas adjacent to intensive human-induced development activities. This EFH would be affected by nearshore oil and gas activities such as pipeline dredging. The primary effects will be increased turbidity and sedimentation of the benthic environment. The EFH in the southern part of Hope Basin and Cook Inlet are delineated both near and offshore. Negative cumulative effects would impact both offshore and nearshore EFH.

Federal and State oil and gas lease activity would contribute to cumulative effects on EFH. Effects on EFH from routine activities would include some increase in turbidity and reduction of water quality as part of EFH, and some sedimentation which will result in smothering of some benthic EFH for some of the managed species and their prey.

The port facility associated with the Red Dog Mine, 27 km south of Kivalina on the coast of the Chukchi Sea, and its activities would add to cumulative effects on EFH. All coastal streams along the shore to approximately 70° N. are EFH (NOAA/NMFS, 1999). Activities along the Red Dog dock would increase turbidity and sedimentation at the site, and vessel traffic emitting harmful effluents to nearshore waters would impact EFH. The dock and causeway are only about 40 m wide and 60 m long and extends out only to a water depth of 4 m. The relatively small dock and shallow depth limit the amount of shipping traffic and, thus, the Red Dog Mine's contribution to the cumulative impact on EFH.

Water quality as part of EFH is also affected by vessel discharges from oil tankers coming into and leaving the terminal in Valdez and traveling to coastal ports from Washington State south to California. Offshore discharges would mix and rapidly dilute within the water column.

Increased cruise vessel traffic would also add to the cumulative impact on EFH in Cook Inlet lease areas because of the ships' effluents and discharges which include oily bilge water. This would reduce water quality as a part of EFH.

There are two ocean dumping sites currently operational offshore Nome, Alaska. Neither site has been extensively used. Dumping will affect the water quality in this area, which contains both water column (walleye pollock adults) and benthic (yellowfin sole adults and late juveniles) EFH for some managed species.

Fishing related activities can also impact on EFH. Within Federal waters of Cook Inlet there is trawling, longlining, and pot fishing for several groundfish species, as well as dredging for scallops and gill netting for salmon. Some of these methods such as trawling and dredging can damage benthic EFH.

Commercial fishing methods in State waters include trawling and pot fishing for shrimp, pot fishing for octopus, and shovel and fork applications for razor clam removal. Several of these methods can also damage or destroy benthic EFH.

Directed fisheries on salmon in Alaska include marine commercial and recreational hook-and-line fisheries. In the marine fisheries, such as in the Chukchi Sea, direct impact of the gear on marine habitats is limited, but some localized effects can occur, such as trolling weights damaging coral, or purse seines damaging kelp beds or benthic structures. In the estuarine and riverine environment, direct fisheries impacts can include destruction of riparian vegetation and channel morphology from boat wakes, and removal of woody debris to provide boat access.

Oil spills from drilling and production activities in State waters and on the OCS could impact EFH in the Alaska Region (Table 4-6c). Damage caused by oil contamination would depend on the size and duration of the spill, time of year, and biota density in the EFH. Multiple spills would further contribute to cumulative effects.

Oil from spills occurring under the ice in the Beaufort and Chukchi Seas will remain trapped there throughout the winter unless removed, which, while difficult, can be done. Surface water EFH will be negatively impacted. Any overwintering eggs, larvae, and invertebrate prey will be killed. Surface spills occurring in the summer months will temporarily reduce surface EFH for surface dwelling eggs, larvae, and pelagic prey species. Oil may travel upriver, some of it trapped in the interstitial spaces of the sediments, and will contaminate EFH for salmon eggs.

In the Gulf of Alaska two tanker spills (7,800 bbl each) of oil from Arctic OCS production and three large tanker spills (7,800 bbl each) from Alaska and North Slope production are assumed to occur under the cumulative scenario. The EFH for many of the managed species at various life stages includes the pelagic and epipelagic waters of the Gulf of Alaska. These oil spills could affect these species in the Gulf of Alaska.

Conclusion: Impacts to EFH from cumulative routine operations will, in most cases, be temporary and **minor**. Cumulative effects on EFH due to oil spills would be **minor**. The extent to which the 2002 OCS Program contributes to the overall impacts from both routine activities and large spills is **minor**.

4.8.3.9.2. National Parks, Refuges, and Forests

National Park System

Seven national parks, monuments, and preserves in Alaska are susceptible to impacts from OCS oil and gas development, as well as from other non-OCS activities, which contribute to the cumulative impact on these areas. These areas are shown in Figures 3-31 and 3-32.

Impacts from routine OCS operations could come from facilities developed to support oil drilling and production, and could include effects from pipeline landfalls, dredging, air pollution, and the construction of roads and new facilities. The OCS cumulative case scenario includes additional pipeline, pipeline landfalls, and new shore bases (Table 4-6b) in addition to the proposed action alone (Table 4-6b). Onshore oil facilities are permissible only on private acreage within each national park land. All seven of these national parks, monuments, and preserves contain privately held acreage, but the development of onshore oil support facilities is unlikely on most of these. Cumulative impacts created by routine activities associated with OCS development are expected to be negligible.

Activities associated with the Red Dog Mine and its present and proposed expanded port facility south of Kivalina on the Chukchi Sea would contribute to cumulative impacts on the Cape Krusenstern National Monument. The road from the mine (located just outside the monument) to the port crosses the northern boundary of the monument. Impacts from this facility, like habitat loss and disturbance, are expected to be minor due to the limited activity associated with the mine.

Increased traffic (i.e., land, sea, and air) and development within the National Park System (especially at Glacier Bay National Park and Reserve, Katmai National Park and Reserve, and Wrangel-St. Elias National Park and Reserve) also contribute to cumulative impacts to all units in the system. Because the amount of traffic is restricted and activities within the parks regulated, traffic would likely create a minor addition to the cumulative impact on the National Park System.

Impacts from accidents would primarily be from oil spilled from onshore facilities, from offshore drill rigs, or from tanker transport (Gulf of Alaska) (Table 4-6b). Oil spills would have the most effect on shoreline habitat and animal communities. Impacts would depend primarily on the spill location, size, and time of year. In general, directly affected coastal fauna could include marine mammals; fishes that reproduce in, inhabit, or migrate through coastal areas; terrestrial mammals that feed on these fishes; and marsh birds and seabirds. Spilled oil could also affect subsistence harvests in those parks in which subsistence hunting and fishing are allowed. Contribution to the cumulative impact on the National Park System by oil spills would be negligible to moderate.

National Wildlife Refuges

Oil drilling and facility development is prohibited in ANWR and is discretionary on all others; however, there are seven refuges (Figures 3-31 and 3-32) that could potentially be affected by OCS oil and gas development from adjacent regions under the cumulative case scenario. These refuges could be contaminated by oil spilled from offshore projects, or could be subject to negative effects from routine operations associated with the development of onshore oil and gas support facilities. They may also be affected by non-OCS activities within or adjacent to the refuge. However, numerous refuge lands have been conveyed to private owners and Native corporations; Section 22(g) of the Arctic Native Claims Settlement Act (ANCSA) (1971) requires that new development on these lands must be in accordance with the purpose for which the refuge was formed. Thus, development of onshore oil and gas support facilities is thus technically possible, but subject to intensive review, as are any other developments.

Four refuges (Alaska Peninsula, Alaska Maritime, ANWR, and the Kodiak Refuge) may also contain subsea lands, which would prohibit OCS oil drilling within varying distance from the shoreline. These subsea lands are presently under review.

The specific effects and magnitude of routine operations and accidental events to the refuges are essentially the same as discussed for the National Park System, above (minor for routine and negligible to moderate for accidental). In addition, subsistence hunting and fishing are permitted on all refuges in Alaska and could therefore be affected by accidents and routine operations.

National Forests

The Chugach and Tongass National Forests are in the subarctic region adjacent to the Gulf of Alaska (Figure 3-32). The Chugach National Forest also borders Prince William Sound and is close to Valdez. The Chugach National Forest is susceptible to routine oil-related operations from transport and tanker loading of oil produced (OCS and non-OCS) in other regions, such as the Beaufort Sea Planning Area, and transported by pipeline to the Port of Valdez. Potential affects include increased noise and air pollution from tanker traffic, habitat loss due to facility and road development, and possible introduction of invasive organisms from jettisoned ballast water. Most effects are already ongoing from existing routine operations, but the development of new sites may extend the temporal or spatial scale of these effects. Impacts are considered minor.

Since no onshore or offshore OCS development will be occurring in the Tongass National Forest in the Gulf of Alaska area, impacts, if any, are expected to be negligible.

Additional, non-OCS-related cumulative impacts in these national forests are related to timber harvest and mining operations (e.g., for gold or gravel/stone). However, the impacts of these activities are considered minor since they are only permitted within the national forest under an approved resource use plan.

The Chugach National Forest is susceptible to oil (mostly non-OCS) spilled from tankers and loading facilities at the Port of Valdez. Oil spills that reached the coastline would affect coastal fauna; subsistence, recreational, and commercial fishing; and tourism. Impacts would depend on the size and timing of a spill and would be expected to be minor to moderate.

Shorelines within the Tongass National Forest are susceptible to contamination from tanker transport in the Gulf of Alaska. Most of these spills are likely to come from non-OCS oil (Table 4-6c). Such spills that reached the coastline would affect coastal fauna; subsistence, recreational, and commercial fishing; and tourism. Impacts are expected to be minor to moderate.

The estimated probabilities of one or more large spills (≥ 500 bbl) occurring from all OCS activities from the cumulative case is provided in Table 4-6c. The probabilities of one or more spills occurring are estimated as 22-26 percent (Cook Inlet), up to 98 percent (Chukchi Sea), and 95-99 percent (Beaufort Sea). Possible large spills from State oil and gas development and from tankers (Gulf of Alaska) are not considered in these estimates.

Conclusion: Impacts to national parks (including monuments and reserves), refuges, and forests from routine activities under the cumulative case would be **negligible** to **minor**. If large oil spills were to occur, the impact to these resources are expected to range from **negligible** to **moderate**, depending on the size, location, and timing of the spillage. The contribution of the proposed action to the cumulative impact from routine operations would be small though the cumulative impact would still be only **minor**. The contribution from oil spills to the cumulative impact from the proposed action would be substantial, although the impact levels (**minor** to **moderate**) would be the same for both scenarios. However, the likelihood of the occurrence of multiple large spills is considered less for the proposed action alone, especially in the Beaufort Sea and the Gulf of Alaska.

4.8.3.10. Population, Employment, and Regional Income

The overall importance of oil and gas in the Alaskan economy has been developed in Sections 3.2.3. and 4.3.3.10. The inevitable decline in oil and gas production and the growth of other economic sectors has also been documented. Recent trends in Alaska indicate that population and employment will increase modestly. Real per capita income (adjusted for inflation) will remain relatively stable. Urban and regional "hub" communities, especially Anchorage, will exhibit more growth than rural areas, even though much of the foreseeable activities will occur in rural areas (Goldsmith and Hill, 1997). Employment generated by these foreseeable activities (and associated secondary employment) will be concentrated in hub communities, or will employ workers from such communities in rural or enclave work settings. Arctic Alaska, especially the North Slope Borough (NSB), likely will be the rural area most affected by cumulative demographic and employment changes. If accidents were to occur, they may cause short-term fluctuations in these trends, but probably would have no long-term effects.

The proposed Chukchi Sea-TAPS pipeline associated with Chukchi Sea OCS development would represent the largest Alaskan construction project since the construction of TAPS. It would have major Statewide effects for the duration of the project. Regional and local effects would depend on the degree to which local and Native hiring programs are used. It is likely that local and Native Alaskans would constitute a higher percentage of employees on these projects than was the case with the construction of TAPS. Alyeska has promised to hire more local and Native Americans in light of their admitted failure to meet local hire requirements set for TAPS (Alyeska Pipeline, 2001). The question of Native hiring is developed at greater length in the *Liberty Development and Production Plan: Draft Environmental Impact Statement,* which is included by reference.

4.8.3.10.1. Arctic

The current pattern of oil and gas development on the North Slope would continue to provide the tax base for the NSB. The NSB tax base may decrease in size somewhat, but should support the continuation of services and the completion of the current NSB capital improvements program. Onshore non-OCS activities would contribute more to this continuation than would OCS activities because the NSB cannot tax offshore development. However, to the extent that OCS production supports the continuing operations of TAPS (and other oil and gas infrastructure), it would also be an important component to the tax base. Foreseeable activities would not have substantial direct employment and demographic regional effects, since most employees would be from larger Alaskan and non-Alaskan communities, working in “hub” communities or in industrial enclaves in rural settings. A great number of NSB jobs would be indirectly supported by foreseeable activities, however, and a large component of expected demographic growth would be attributable to these activities. Most of this growth should occur in Barrow (the NSB regional hub and service center), but the smaller communities should also increase somewhat in size. Such growth depends heavily on the availability of new housing.

The same pattern would be evident in the Chukchi Sea and Hope Basin subregions, with anticipated growth occurring primarily in regional hub communities. The proposed OCS activities in the Chukchi Sea area would increase the tax base substantially, due to the construction of a pipeline from the Chukchi Sea to the TAPS.

Accidents based on the supplied scenarios will be relatively short-term events. Response equipment will be stockpiled at strategic, designated locations. Spill event initial responders will likely be locally based, with non-Alaska personnel flown in as necessary, depending on the size of the spill.

4.8.3.10.2. Subarctic

Because of its proximity to Anchorage, the effects of non-OCS activities on the Cook Inlet area would greatly overshadow those of OCS activities. In other words non-OCS activities would be the primary economic and demographic drivers for this region. However, the impact of OCS activities will not be negligible because much of the direct and indirect employment associated with OCS activities would be located in this region.

As was true for the arctic, accidents based on the supplied scenarios will be relatively short-term events. Response equipment is stockpiled at designated locations. Spill event initial responders will likely be locally based, with non-Alaska personnel flown in as necessary, in the event of a very large spill.

Conclusions: Cumulative effects of routine OCS activities in the arctic region would be **moderate** (long term). The maintenance of local spill response teams and equipment to deal with accidents would supply some economic benefit to the regions, but would have only **negligible** to **minor** population, employment, and income effects. Larger spill events requiring the hiring of more locals or the importation from other regions of response personnel would have potentially greater short-term economic effects, but should have no lasting effects. Because other sectors are growing in importance in the subarctic area, cumulative OCS activities would have only **minor** to **moderate** long-term effects on the region. In general, the proposed action would have **minor** effects on cumulative population, employment, and regional income in both the arctic and subarctic regions. However, should oil and natural gas development in the Chukchi Sea lead to construction of the Chukchi Sea to TAPS pipeline, that action would have **major** short-term effects on employment and regional income, especially if a natural gas pipeline were under construction at the same time.

4.8.3.11. Land Use and Existing Infrastructure

Cumulative effects on land use and existing infrastructure in Alaska would primarily be a continuation of existing trends. Mining and commercial fishing port developments may be of benefit to the oil and gas industry, and more particularly to OCS activity. Conversely, OCS activity may support infrastructure development that supports non-OCS development. Such infrastructure development can supplement other facilities and transportation. Air travel facilities and schedules are heavily influenced by petroleum industry needs. While infrastructure may support non-OCS development, changes in land-use patterns and the construction of new pipelines may have some conflicting associated effects.

Due to Alaska's geography, size, and lack of surface transportation, air carriers provide a large share of the cargo and passenger service to and within the State. Water transport, especially for large and heavy materials, is also quite important. All OCS and non-OCS activities would have direct and indirect effects on Alaska's air routes and air-terminal facilities, and on barge-cargo services.

In the arctic region, notwithstanding the port developments associated with the Red Dog Mine or commercial fishing in the Bering Sea, any OCS activities in the Chukchi Sea and Hope Basin areas would require more infrastructure development. Such development would facilitate other, non-OCS development projects. The magnitude of this potential effect is unclear, however.

Pipelines and roads required for anticipated OCS activities would generally be in areas already used in this way and thus would impose only minor effects. The exception is the pipeline required to transport produced oil from the Chukchi Sea to the TAPS. This 600-mile-plus pipeline would be constructed through lands that are currently relatively inaccessible, except by aircraft or snow machine in winter. These lands are used for subsistence.

North Slope transportation networks would be relatively unaffected by anticipated OCS and non-OCS activities. The trend has been towards increased service (both in terms of frequency and size of plane) for all communities. For the Chukchi Sea and Hope Basin Planning Areas, new air facilities would have to be developed near the pipeline landfall. The Chukchi Sea-TAPS pipeline would also require the construction of either a service road or small airstrips. Such facilities would not be open to public access, at least initially. Expansion of the Red Dog Mine would require expansion of associated port facilities, as would continued mineral development in the Norton Sound area.

In the subarctic, cumulative effects in the Cook Inlet area should be minor, as most development, both OCS and non-OCS, would be in areas already subject to such development. New wells, pipelines, and roads would represent incremental infrastructure increases, but should produce at most minor cumulative effects in terms of land use.

Generally, the cumulative effects of non-OCS activities on transportation networks in this region would far outweigh those of OCS activities. OCS activities would contribute to the continued expansion of air and port facilities in Anchorage and on the Kenai Peninsula, but the percentage attributable to OCS activities would be difficult to determine. Anchorage is the major cargo hub (air and water) for Alaska. Increased air and water transportation linkages, to the extent that they do not have socioeconomic benefits to communities, should be mitigated through lease stipulations. These transportation improvements, required for OCS development in the area, could also be beneficial for further development of commercial fishing and tourism in the area.

Neither cumulative nor proposed action incremental oil spills will have much effect on subarctic land use and existing infrastructure. It is likely that offshore spill response will use existing port and other facilities developed for the proposed program.

Conclusion**:** For the arctic region, infrastructure for future OCS activity on the North Slope is currently reasonably well developed, and cumulative effects on land use should be **minor**. A pipeline to TAPS would represent a **moderate**, and potentially a **major,** effect in terms of changed land use if proper measures are not taken to consider subsistence harvest patterns. For the subarctic region, developments may have greater short-term effects, but long-term cumulative land-use effects should also be **minor**. Cumulative incremental oil-spills effects on arctic land use and infrastructure would be **minor**. That is, existing incremental port and other facilities from the proposed action would be used.

4.8.3.12. Fisheries

Logging in the Tongass National Forest has been shown to have effects on the riverine habitat of salmon, including erosion, increased sedimentation, introduction of fine particles into gravel substrates, canopy removal, and downed timber in the rivers. These factors have various effects on salmon, which are discussed in more detail in Section 4.8.3.6.

Contaminants in the effluents from cruise ships may have an effect on fisheries by increasing the biochemical oxygen demand and reducing the amount of oxygen available in the water column. Suspended solids in effluents may settle on the bottom, smothering bottom incubating eggs (Alaska Department of Environmental Conservation, Division of Statewide Public Service, 2001). Cruise ship effluents may have minor impacts on commercial fishing.

Routine OCS and non-OCS activities in the Alaska Region under the cumulative scenario are not expected to significantly affect commercial fishing. The incremental increases in routine operations activity in the cumulative case scenario (Table 4-6b) are expected to have negligible impacts on commercial fishing.

Spill events from tankers transporting oil could have dramatic effects, including substantial loss to the commercial fishing industry for 2 years following the spill, as well as an extended period of litigation and uncertainty as to longer term effects. Incremental spills contributed by the proposal to the cumulative spill scenario (Table 4-6b) are relatively small, and such impacts are expected to be minor to moderate, depending on the location and timing of the spill with respect to the fisheries affected.

Conclusions: The cumulative impacts to fisheries in the Alaska Region associated with routine OCS and non-OCS activities would be **negligible**. The cumulative impact to fisheries from large oil spills from all sources would be **minor**. However, localized impacts from oil spills could be **moderate**. The incremental contribution to cumulative impacts from routine activities and oil spills from the 2002 OCS Program are expected to be **negligible** to **minor**.

4.8.3.13. Tourism and Recreation

Much Alaska tourism and recreation is attracted by the wilderness nature of the State. Anything that detracts from the perception of wilderness would tend to have a negative impact on tourism and recreation. Thus, population growth, industrial development, or pollution will have a negative impact. The State's population and industrial growth is relatively slow. Given the vast areas of undeveloped land and shoreline left in Alaska, population growth and industrial development will probably not have significant impacts on tourism and recreation. The OCS activities could be viewed from coastal communities and tour ships although visual impacts are not likely from activities located further than 16 km from shore. Such potential visual impacts are more likely for Cook Inlet, one of the areas of most developed tourism and recreation, than for arctic Alaska. The cumulative effects of OCS support services (air and water traffic) and trash and debris from OCS activities also may detract from the quality of recreational and tourist experiences. Nevertheless, the potential harm to these resources is relatively limited. The proposed action will not add greatly to any of the forces with negative impacts on tourism and recreation resources.

The combination of North Slope onshore oil, cumulative State and Federal offshore oil, and oil from the proposed action provide a fairly significant risk of a large oil spill. For arctic Alaska, the risk of negative spill effects on tourism and recreation would be relatively small because of the limited nature of recreational and tourist activities. For Cook Inlet, such potential effects are greater and could be fairly significant. Guided sportfishing is an important economic activity in the communities of Prince William Sound (near the TAPS terminal in Valdez). The *Exxon Valdez* oil spill demonstrated that a spill event could depress client bookings for sportfishing and other recreational activities for several years. Spills directly related to OCS activities would have little likelihood of such great effects, but in the cumulative case, such effects are more probable. The proposed action adds only modestly to the cumulative risk of an oil spill and resulting damage to tourism and recreation.

Conclusion: Cumulative effects on Alaskan tourism and recreation from routine activities are likely to be **minor.** The cumulative risk of large oil spills having a negative impact on tourism and recreation would be **minor** in the arctic but **moderate** in Cook Inlet. The risk would also be **moderate** in Prince William Sound through which oil-laden tankers must pass on their way to the west coast and East Asia. The proposed action would make no more than a **minor** addition to the risk of damage to these resources.

4.8.3.14. Sociocultural Systems

The cumulative effects of OCS and non-OCS activities on sociocultural systems would be community specific and, in most cases, would not represent any new industrial (or other) activities. For OCS activities, most supply and support bases would be located near existing industrial infrastructure. Changes associated with the number and characteristics of population and employment associated with industrial growth would also be community specific (see demographic and economic section above). Industrial enclaves have, in general, reduced industry-local community interaction and have reduced potential social disruption. To the extent that projected development can fit this model, effects may be minimized. The assessment of "non-OCS" effects in this area is quite difficult since all sociocultural systems are in constant flux and change. Nevertheless, one of the most serious concerns to North Slope Inupiat is that potential increases in noise from cumulative oil development could disrupt normal migration of bowhead whales, forcing subsistence whalers into longer hunts farther from shore. Recently, Eugene Brower, president of the Barrow Whaling Captains' Association, articulated the issue in a statement he made at the January 6, 2000, meeting of the MMS Regional Offshore Advisory Committee:

> I have the responsibility of talking on behalf of my whaling captains in Barrow. There's 44 captains with 550 plus crew members that have great concern for the lease sales . . . the area of concern that we're talking about is the whole migration route of the bowhead whale. What goes on in the eastern portion of the Canadian Border all the way through Barrow impacts three villages. [For] their livelihood, we have great concern . . . . The concern is always the same . . . but what impacts Kaktovik impacts Barrow and Nuiqsut in the middle. Anything that goes [on] in the east impacts us all the way to Barrow. And I, for one, would never want to see permanent structures out in the open sea because of the experience we had from. . . one little platform off Cooper Island, five miles offshore. It was stationary, just idling. Just the noise being emitted from that structure was enough to divert the bowhead whales further out. There was nothing in between them but nothing went through. It was always on the outside. So if you're going to be putting permanent facilities out in the water on the Beaufort, it's going to be making a lot of noise with the gravel pad, whatever structure you put out there. It's going to impact our livelihood. (USDOI, MMS, 2001)

Further, increased industrialization of the arctic region may lead to increased exposure of local residents to social health and well-being risk factors. Change associated with Euroamerican contact, including industrial development, has been extensive and compressed within a relatively short period of time. Such change has certainly been correlated with increased rates and duration of dysfunctional and pathological behavior, such as substance abuse, domestic violence, spouse and child abuse, rape, homicide, and suicide (as well as a host of more positive dynamics, of course). The OCS activities contribute to this dynamic, primarily in a supplementary fashion (Louis Berger and Associates, Inc., 1983).

However, more concretely, OCS activities would affect subsistence (and thus sociocultural systems) in a potentially major way. Lease stipulations should mitigate some of these effects to a degree, as noted in the discussion of subsistence below. Because subsistence is to a large extent the ideological idiom of Inupiat (and Alaskan Native) culture, this is a fundamentally important category of potential effects and extends very broadly. Effects may result from routine exploration, development, and production activities as well as from spill events. The Chukchi Sea-TAPS pipeline is also a significant vector for such effects.

The disruption of marine mammal harvests (primarily whales, but potentially also seals) could result from potential diversion of the whale migration further offshore, or from other behavior changes by the animals (making them more skittish, for example) in reaction to OCS activities. The greater the degree of OCS development (as measured by number of wells, east-to-west area of development, or some other metric), the more probable and more pronounced such an effect is likely to be. Lease sale stipulations have, to a large extent, mitigated such potential effects for exploration and development activities, and may continue to do so. No OCS production has yet started in the arctic region, and potential effects and required mitigation measures are still speculative. It is likely that such potential effects can be effectively mitigated.

The importance of subsistence activities both in terms of household economy and cultural identity has been discussed in Sections 3.2.3.5 and 4.3.3.11. Potential direct and indirect effects of the proposed action have also been discussed. Significant cumulative effects upon subsistence resource use are possible and likely.

The Chukchi Sea-TAPS pipeline would cross an area that is currently not crossed by pipelines or roads, and has limited airstrip facilities. Such a pipeline would change the nature of the area for subsistence use, and could potentially increase competition for subsistence resources by providing access for other user groups. Pipelines and roads, in general, can deter subsistence users from continuing to use an area. The cumulative effects of such a pipeline and associated service facilities would range from moderate to major, dependent upon local consultation to develop appropriate mitigation measures. The incremental effect of the Chukchi Sea-TAPS pipeline will also potentially be moderate to major, as it will be the “last link” in the industrial fence around Nuiqsut.

The sociocultural system of the Cook Inlet region to a large extent incorporates both OCS and non-OCS development activities. Some relatively small Native communities display similar dynamics as those discussed above for arctic Alaska. Rural communities of Prince William Sound have demonstrated their susceptibility to sociocultural disruption from large-scale, time-compressed events (that is, the 1989 *Exxon Valdez* oil spill event), and are also subject to disruptions of subsistence resource use.

For the subarctic region, noise and increased vessel traffic may affect the harvest of subsistence resources. Lease sale stipulations (seasonal activity restrictions) should adequately mitigate this potential effect.

Cook Inlet beluga are presently a depleted species. However, industry activities are not thought to be a cause of this situation. Alaska Natives are allowed to harvest marine mammals, but through a co-management agreement, the subsistence harvest of this population of beluga is currently very restricted.

Oil-spill events pose the greatest potential for cumulative effects. Past environmental analyses for Federal OCS lease sales in the Beaufort and Chukchi Seas assess the cumulative impact risk of one or more important subsistence resources becoming unavailable, undesirable for use, or greatly reduced in numbers for a period of 1 or 2 years as very likely (USDOI, MMS, 2001). Adding several more active leases would logically increase the duration of limited or no access to important subsistence resources. The specific resources considered in these analyses varied, but included anadromous fishes affected by pipeline river crossings and potential spills, walruses and seals affected by pipeline landfalls and support bases, bowhead whales affected by noise and potential oil spills, and caribou affected by pipeline landfalls and onshore oil field activities. Potential cumulative effects of OCS activities would have the potential to be major, due to spill events.

Cumulative effects of OCS and non-OCS activities on subsistence in the subarctic would be confined for the most part to spill events, except for the areas mentioned above. Some tankering of oil takes place in Cook Inlet, but for the most part, future OCS and non-OCS oil from the arctic would be mixed in the TAPS pipeline, and spills cannot be attributed to one or the other. Subsistence in Prince Williams Sound or coastal areas of the Gulf of Alaska could be affected by spills from tankers carrying arctic oil from Valdez to west coast ports.

Spill events could have moderate cumulative effects for this area, especially for rural communities. Native communities may be somewhat more at risk than non-Native communities because of their subsistence practices.

The potential cumulative effects of spill events can be estimated, in part, by the 1989 *Exxon Valdez* oil spill. This event has the advantage of being a real large-scale case for which reasonably good information is available. Large spill events have the potential to produce major cumulative effects in this regard, as evidenced by the continuing aftermath of the *Exxon Valdez* oil spill. The arctic Alaska region would be subject to the same social disruption of such a cleanup effort, aside from the potential effects of a spill itself, and the ability to clean up a spill in the arctic has not yet been demonstrated, thus the impact could be major.

Conclusion: The cumulative effects of OCS activities on general sociocultural systems should be **minor**, as OCS activities would be confined for the most part to industrial enclaves. The cumulative effects of non-OCS activities would continue to be **major**, as much of the existing social and economic organizations for the communities of the NSB, Chukchi Sea, and Hope Basin regions are based on such activities.

The cumulative effects of pipelines and associated service facilities would range from **moderate** to **major**, dependent upon local consultation to develop appropriate mitigation measures. The incremental effect of the Chukchi Sea-TAPS pipeline could also potentially be **moderate** to **major**, as it would be the "last link" in the industrial fence around Nuiqsut.

For the subarctic region, noise and increased vessel traffic may affect the harvest of subsistence resources. Lease sale stipulations (seasonal activity restrictions) should adequately mitigate this potential effect. Effects should be **negligible** to **minor**.

The overall cumulative impact of oil spills could be **major**. The incremental addition of the proposed action to this sort of event would be **negligible**. The proposed action does not significantly increase the effect of the cumulative oil-spill scenario.

4.8.3.15. Environmental Justice

Potential cumulative effects on environmental justice are best discussed at a very broad and general level. The OCS activity is a component of the overall petroleum economic sector, which is the major economic driver in the State of Alaska (rivaled only by government). Such activities, as with most of Alaska's other natural resource extractive activities, occur primarily in rural, less populated parts of the State. The perceived differences between rural and urban Alaska on a wide range of measures, such as per capita income, quality of housing, level of education, and the availability and quality of services, are often summed up with the label "urban-rural divide." As rural Alaska is also more predominantly Native (minority) than is urban Alaska, environmental justice issues are primarily rural issues. Effects of OCS activities would be evident most directly in coastal areas, which are primarily rural and Native. As such, they would reinforce the dynamics creating environmental justice issues in the State. Non-OCS activities would also be important contributors to these dynamics.

Many mitigation measures have been devised to address such environmental justice issues. The direct and indirect effects referred to in Section 4.3.3.15 discusses those specifically taken by MMS as an agency. More generally, local (Alaska) and Native hire preference programs have been implemented to ensure that those who are potentially most adversely affected share the benefits of development projects, whether economically or in other ways. Industry has also developed extensive local outreach programs, at least partially in response to lease stipulations developed by MMS in consultation with potentially affected local groups.

The importance of subsistence activities both in terms of household economy and cultural identity has been discussed in previous sections (Sections 3.2.3.5 and 4.3.3.14). Potential direct and indirect effects of the proposed action have also been discussed. Significant cumulative effects upon subsistence resource use are possible and likely, and are the focus of this section.

In the arctic region, OCS activities could contribute to cumulative effects in several ways. The disruption of marine mammal harvests (primarily whales, but potentially also seals) could result from the potential diversion of the whale migration further offshore, or from other behavior changes of the animals (making them more skittish, for example) in reaction to OCS activities. The greater the degree of OCS development (as measured by number of wells, east-to-west area of development, or some other metric), the more probable and more pronounced such an effect is likely to be. Lease sale stipulations have, to a large extent, mitigated such potential effects for exploration and development activities, and may continue to do so. No OCS production has yet started in this region, and potential effects and required mitigation measures are still speculative. It is likely that such potential effects can be effectively mitigated.

In the subarctic region, cumulative effects of OCS and non-OCS activities on subsistence in this area would be confined, for the most part, to spill events, except for the Gulf of Alaska around Yakutat and possibly Cook Inlet beluga whales. Some tankering of oil takes place in Cook Inlet, but for the most part, future OCS and non-OCS oil would be mixed in the TAPS pipeline, and spills cannot be attributed to one or the other.

Spill events, in the arctic region, pose the greatest potential for cumulative effects. Past environmental analyses for Federal OCS lease sales in the Beaufort and Chukchi Seas assess the cumulative impact risk of one or more important subsistence resources becoming unavailable, undesirable for use, or greatly reduced in numbers for a period of 1 or 2 years as very likely (USDOI, MMS, 2001). Adding several more active leases would logically increase the duration of limited or no access to important subsistence resources. The specific resources considered in these analyses varied, but included anadromous fishes affected by pipeline river crossings and potential spills, walruses and seals affected by pipeline landfalls and support bases, bowhead whales affected by noise and potential oil spills, and caribou affected by pipeline landfalls and onshore oil field activities. The potential effects of spill cleanup activities must also be considered in this assessment. Potential cumulative effects of OCS activities would have the potential to be major, due to spill events.

Production pipelines associated with oil and gas development in the Hope Basin would be short, but pipeline spills would also be possible. Since the volume of oil would be much smaller, the risk would also be smaller, but the potential effects would be similar to effects from larger spills.

Conclusion: In summary, both OCS and non-OCS activities could have high adverse environmental and health effects if a large oil spill were to occur. Mitigation measures have been developed to help alleviate these effects and to avoid conflict with Native subsistence activities. Such effects may never be completely eliminated, but the outreach process ensures local participation and the greatest degree of advancement to that goal. The incremental addition of the proposed action to this sort of event will not have disproportionate high/adverse environmental justice impacts. That is, the proposed action would not significantly increase the effects of the cumulative oil-spill scenario.

4.8.3.16. Archaeological Resources

The following analysis considers the effects of trawling, channel dredging, non-OCS construction projects, and activities associated with the proposed action, prior, and future OCS sales in the Alaska Region. Specific types of impact-producing factors related to OCS mineral development considered in this analysis include drilling rig and platform emplacement, pipeline emplacement, new onshore facilities, and oil spills. The effects of natural geologic processes such as ice gouging and thermokarst erosion on the archaeological resource base of the Alaska Region are also considered.

Prehistoric Resources

Offshore development could result in an interaction between a drilling rig, platform, pipeline, or anchors and an inundated prehistoric site. This direct physical contact with a site could destroy artifacts or site features and could disturb the stratigraphic context of the site. The result would be the loss of archaeological data on prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts between northeast Asia and the Americas.

The MMS currently requires that an archaeological survey be conducted prior to development of mineral leases determined to have potential for prehistoric archaeological sites. Relative sea-level data, which are used to define the portion of the continental shelf having potential for prehistoric sites, are sparse in the Alaska Region; however, the data that do exist suggest that the portion of the continental shelf shoreward of about the 60-m isobath would have potential for prehistoric sites. It is assumed that the archaeological survey has effectively mitigated most impacts from routine operations related to OCS mineral exploration activities. However, impacts to prehistoric resources may have resulted from OCS routine activities prior to the implementation of the archaeological survey requirement, but the magnitude of this possible impact is impossible to quantify.

Onshore development could result in direct physical contact between the construction of new onshore facilities or pipeline trenches and previously unidentified prehistoric sites. This direct physical contact with a prehistoric site could cause physical damage to, or complete destruction of, information on the prehistory of the region and North America. Federal and State laws and regulations initiated in the 1960’s began requiring archaeological surveys prior to permitting any activity that might disturb a significant archaeological site. Therefore, it can be assumed that, since the introduction of the archaeological resource protection laws, most coastal archaeological sites have been located, evaluated, and mitigated prior to construction. However, impacts to coastal prehistoric resources may have resulted from onshore construction activities prior to enactment of the archaeological resource protection laws, but the magnitude of this possible impact is impossible to quantify.

Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high probability for prehistoric archaeological sites as they are usually associated with drowned river valleys, which are known to have a high probability for prehistoric sites. It is assumed that some of the archaeological data that have been lost as a result of dredging have been significant and unique; therefore, the impact to prehistoric archaeological sites as a result of past channel dredging activities has probably been moderate to major. In many areas, the COE now requires remote sensing surveys prior to dredging activities to minimize such impacts (Espey, Huston & Associates, 1990).

Trawling activity in the Alaska Region only affects the uppermost portion of the sediment column (Krost, et al. 1990). This zone would already be disturbed by natural factors relating to the destructive effects of marine transgression and continuing effects of wave and current action. Therefore, the effect of trawling on most prehistoric archaeological sites would be minor.

Natural geologic processes such as ice gouging, and thermokarst erosion have caused and will continue to cause a significant loss of prehistoric archaeological data in the Alaska Region. The largest ice gouges on the Beaufort Sea shelf can disturb sediments as deep as 4 m below the seafloor, but the average depth is about 0.5 m (Barnes, 1984). Coastal prehistoric sites are exposed to the destructive effects of thermokarst erosion. These natural processes would cause artifacts to be dispersed and the site context to be disturbed or even completely destroyed, resulting in the loss of archaeological information. Overall, a significant loss of data from submerged and coastal prehistoric sites has probably occurred, and will continue to occur, from the effects of natural geologic processes in the Alaska Region. It is assumed that some of the data lost have been significant and/or unique, resulting in a major level of impact.

The cumulative case scenario includes assumptions of the number, size, and probability of occurrence of oil spills from OCS activities and an estimate of the number of large spills from import tankers (Table 4-6c). An accidental oil spill could impact coastal prehistoric archaeological sites. Archaeological resource protection during an oil spill requires specific knowledge of the resource's location, condition, nature, and extent prior to impact; however, the Alaska coastline has not been systematically surveyed for archaeological sites.

Heavy oiling of a coastal area (Whitney, 1994) could conceal intertidal sites that may not be recognized until they are inadvertently damaged during cleanup. Crude oil may also contaminate organic material used in ^{14}C dating, and, although there are methods for cleaning contaminated ^{14}C samples, greater expense is incurred (Dekin et al., 1993). The major source of potential impact from oil spills is the harm that could result from unmonitored shoreline cleanup activities. Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with effective training and supervision. Damage or loss of significant archaeological information could result from the contact between an oil spill and a prehistoric archaeological site, but it is unlikely that entire sites would be destroyed without any mitigation during clean-up activities; therefore, the cumulative impact from oil spills to prehistoric archaeological sites would probably be moderate.

Historic Resources

Direct physical contact between a routine activity and a shipwreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb the site context. The result would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel's crew, and the concomitant loss of information on maritime culture for the time period from which the ship dates.

The MMS currently requires that an archaeological survey be conducted prior to development of mineral leases when a historic-period shipwreck is reported to lie within or adjacent to the lease area. It is assumed that the archaeological survey has effectively mitigated most impacts from routine operations related to OCS mineral exploration activities. However, impacts to historic-period shipwrecks may have resulted from OCS routine activities prior to the implementation of the archaeological survey requirement but the magnitude of this possible impact is impossible to quantify.

Onshore development could result in direct physical contact between the construction of new onshore facilities or pipeline trenches and previously unidentified historic sites. Federal and State laws and regulations initiated in the 1960's began requiring archaeological surveys prior to permitting any activity that might disturb a significant archaeological site. Therefore, it can be assumed that, since the introduction of the archaeological resource protection laws, most coastal archaeological sites have been located, evaluated, and mitigated prior to construction. However, impacts to coastal historic sites may have resulted from onshore construction activities prior to enactment of the archaeological resource protection laws, but the magnitude of this possible impact is impossible to quantify.

Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high probability for historic shipwrecks. Assuming that some of the data lost have been unique, the impact to historic sites as a result of past channel dredging activities has probably been moderate to major. In many areas, the COE now requires remote sensing surveys prior to dredging activities to minimize such impacts (Espey, Huston & Associates, 1990).

Trawling activity in the Alaska Region only affects the uppermost portion of the sediment column (Krost, et al. 1990). On many wrecks, this zone would already be disturbed by natural factors and would contain only artifacts of low specific gravity which have lost all original context. Therefore, the effect of trawling on most historic shipwreck sites would be minor.

Natural geologic processes such as ice gouging, and thermokarst erosion have caused and will continue to cause a significant loss of historic data in the Alaska Region. The largest ice gouges on the Beaufort Sea shelf can create a furrow up to 67 m wide and 4 m deep; however, the average ice gouge is about 8 m wide and 0.5 m deep (Barnes, 1984). If a shipwreck were to occur in an area of intense ice gouging, it would be destroyed. Coastal historic sites are exposed to the destructive effects of thermokarst erosion; causing artifacts to be dispersed and the site context to be disturbed or even completely destroyed. Overall, a significant loss of data from submerged and coastal historic sites has probably occurred, and will continue to occur, from the effects of natural geologic processes in the Alaska Region. It is assumed that some of the data lost have been significant and/or unique, resulting in a major level of impact.

The cumulative case scenario includes assumptions of the number, size, and probability of occurrence of oil spills from OCS activities and an estimate of the number of large spills from import tankers **(**Table 4-6c). An accidental oil spill could impact a coastal historic site, but the direct impact of oil on most historic sites would be temporary and reversible. The major source of potential impact from oil spills is the harm that could result from unmonitored shoreline cleanup activities. Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with effective training and supervision. Damage or loss of significant historic information could result from oil spill cleanup activities, but it is unlikely that entire sites would be destroyed without any mitigation during cleanup activities; therefore, the cumulative impact from oil spills to historic archaeological sites would probably be moderate.

Conclusion: Under the cumulative scenario, the impact to both prehistoric and historic archaeological sites from routine activities should be **minor** due to archaeological surveys which are required prior to disturbance. However, routine activities that were approved prior to initiating the survey requirement may have impacted significant archaeological sites, but the magnitude of this possible impact is impossible to quantify. Of the non-OCS related factors that impact archaeological sites, channel dredging and natural geologic processes, such as ice gouging and thermokarst erosion, could possibly cause a **major** impact to both prehistoric and historic sites. The primary oil-spill impacts to both prehistoric and historic archaeological sties would result from cleanup activities, and it is estimated that this impact would be **moderate**. The incremental contribution of the proposal to the cumulative impacts on archaeological resources should be very small due to the archaeological surveys that are required prior to disturbance.

4.8.4. Pacific Region

4.8.4.1. Water Quality

Cumulative impacts on water quality would result when the impacts of tankers carrying Alaska OCS oil are added to other present and reasonably foreseeable actions in the Pacific OCS Region. Such actions include: ocean dumping, harbor dredging and maintenance, municipal wastewater discharges and other onshore effluents, State oil and gas exploration and development, and Alaskan and foreign import tankering.

The impacts from offshore dumpsites are usually limited to the local surrounding area and are similar to those resulting from the discharge of drilling muds and cuttings at drilling locations, with water quality parameters returning to background levels within 1,000-2,000 m of the dumpsite. Harbor dredging and maintenance activities can cause resuspension of sediment during the dredging process. Additionally, port activities generally can cause chronic deterioration of water quality in the local area, with increases in the levels of oil and grease, suspended solids, and trace metals being common. In the Pacific OCS Region as a whole, the volume of sediment from rivers (principally the Columbia River) is by far the largest component of pollutants in terms of volume and easily overshadows all other sources, while municipal and industrial wastewater discharges are the largest source of pollutants in terms of concentrated input. Impacts are greatest near large metropolitan areas such as Puget Sound, San Francisco Bay, and, particularly, the Los Angeles-San Diego area. Regulated discharges from California State oil and gas extraction operations can affect water quality in a manner similar to OCS operations, with some mortality of marine organisms within about 500 m of discharge sites and elevated levels of contaminants and turbidity within about 2,000 m of the operations. Beyond these distances, mixing and dilution will rapidly reduce levels of water quality parameters to ambient concentrations. Alaska and foreign tanker discharges will occur while the vessel is in transit, facilitating dispersion. Compliance with discharge regulations coupled with dilution and dispersion will result in a quick return of the water quality back to normal. As a result, only localized and short-lived water quality degradation will occur while the tanker is in transit. The contribution of routine activities from the proposed action to cumulative impacts to water quality would be minor.

The possible sources of accidental oil spills that are considered in the cumulative effects are found in Table 4-6c. Included are spills associated with the tankering of Alaskan-produced oil through TAPS (three 7,800-bbl spills) and the tankering of imported foreign oil (five 7,800-bbl spills). These are non-OCS-related activities and could occur with or without implementation of the proposed program. The remaining possible oil spill sources include the transport of oil produced by existing, assumed, and proposed OCS activities in the Alaska Region (two 7,800-bbl spill) and a pipeline spill associated with OCS production in southern California (one 4,600-bbl spill). Impacts to water quality from such spills would be variable and of short duration depending upon exposure to currents, wind, and turbulence. Sustained degradation of water quality from hydrocarbon contamination from a large spill is possible but not likely, again depending upon decomposition and weathering processes that would vary between areas due to temperature, storms, and turbulence. If these spills were to occur, they would temporarily reduce the affected water quality and would add associated contaminants into the water column.

Conclusion: The overall cumulative impact to water quality from routine OCS and non-OCS activities is expected to be to **minor**. If large oil spills from any of the potential sources (foreign tankers, OCS tankers, OCS pipelines) were to occur, the overall impact to water quality could be

minor. The contribution of the 2002 OCS Program to the overall cumulative impacts from routine activities and large spills is expected to be **minor.**

4.8.4.2. Air Quality

The cumulative analysis considers the impacts from tanker traffic carrying OCS Alaska oil production to West Coast ports, tankers carrying other Alaska crude and imported oil, and onshore emissions.

Tanker ports located in and around San Francisco and Long Beach in California are in ozone nonattainment areas. While emissions of NO_x and VOC are being reduced through the SIP process, it is likely that the standards would still be exceeded for at least one more decade. The cumulative impacts from all emissions sources in the ozone nonattainment areas would range from moderate to major. The cumulative impacts in the Puget Sound region of Washington would be minor because pollutant concentrations are expected to be within Federal standards.

Tankers carrying crude oil produced in the Alaska OCS would emit NO_x, SO_2, PM_{10}, and CO while they are in transit or operating in or around port. The largest emission source would be in the form of NO_x. The transit emissions would have a negligible impact on onshore air quality because of the distance from shore and because emissions are spread over a distance due to the ship's motion. Unloading of crude oil in port would result in emissions from the engines used in driving the pumps and in fugitive VOC emissions. Nitrogen oxide and VOC emissions have the potential to contribute to ozone formation under favorable meteorological conditions. Potential impacts from tankers are reduced because of the applicable local emission control requirements, which would include the use of VOC emission control measures. The contribution of the tankers to total emissions in the port areas would be very small.

In the cumulative case, there would be about twice as many tanker visits carrying Alaska OCS crude oil compared to the number for the proposed 5-year program. However, this number would still be small compared to the number of tankers and cargo vessels that arrive at west coast ports from overseas. Also, the number of tanker trips carrying crude oil from Prudhoe Bay to the west coast is projected to decline as oil production in that area decreases with time.

The air quality impacts from tankers associated with the proposed 5-year program would be minor.

Large accidental oil spills would cause rather localized VOC concentrations in the ambient air due to evaporation of the spill. Most of the emissions would occur within a few hours of the spill. After that period, emissions would be significantly reduced. A discussion of the effects of large oil spills on air quality is presented in Section 4.3.2.2.

In situ burning of a spill would result in emissions of NO_2, SO_2, CO, and PM_{10} and would generate a plume of black smoke. A discussion of the effects of in situ burning is presented in Section 4.3.2.2. Studies of in situ burn experiments have shown that air quality impacts are localized and short-lived and pollutant concentrations do not pose a health hazard to persons in the vicinity.

Two tanker oil spills of 7,800 bbl are projected along the west coast as a result of the cumulative Alaska OCS oil production. This is the same as the predicted number for the proposed 5-year program. About eight large spills are assumed to occur from tankers associated with other Alaska oil production and with imports (Table 4-6c). The air quality impacts from an individual spill would be similar regardless of the source of the oil.

In summary, any air quality impacts from oil spills would be localized and of short duration. Emissions do not appear to be hazardous to human health. The impacts from in situ burning are also very temporary. Pollutant concentrations would not be expected to be within the NAAQS. The air quality impacts from oil spills and in situ burning would, therefore, be minor.

Conclusion: The cumulative air quality impacts due to all emission sources around the west coast ports would range from **minor** to **major**. Air quality impacts would be **moderate** to **major** in areas where ozone levels exceed the Federal standards. Large oil spills, were they do occur, would have **minor** impacts on air quality. Routine tanker emissions associated with the proposed 5-year program would have **minor** impacts on air quality. A large oil spill associated with the proposed 2002 OCS Program would have **minor** impacts on air quality.

4.8.4.3. Marine Mammals

4.8.4.3.1. Cetaceans

A number of human activities and natural phenomena can have adverse effects on marine mammals such as cetaceans in the Pacific Region, including recreational, commercial, industrial, and military activities, scientific research, climate change, and meteorological events. An unusual mortality event involving gray whales (*Eschrichtius robustus*) along the west coast of the United States occurred in 1999. From January to October, a total of 273 gray whales were reported stranded off the west coast from Baja California to Alaska. A number of the stranded gray whales, as well as live animals sighted during the fall migration, were emaciated, suggesting nutritional problems. Some scientists hypothesize that the rebounding gray whale population has reached carrying capacity for its feeding grounds in the Bering Sea (one of three feeding grounds in Alaska). Concentrations of PCB's and DDT in the blubber of animals were sampled and were found to be highly variable, ranging several orders of magnitude.

The gray whale is the only cetacean in the Pacific Region that is taken for aboriginal subsistence. The Makah Indian Tribe received a 5-year quota from the IWC in 1997 to harvest 20 gray whales for ceremonial and subsistence purposes at a rate of 5 whales per year between 1998 and 2002. The remainder of the subsistence quota for gray whales set by the IWC (620 gray whales for 5 years) is taken by Natives in Russia.

From 1990 to 1998, 47 gray whales were reported entangled in fishing gear off the coasts of Alaska, Washington, Oregon, and California. Of these animals, 13 appeared to have survived; the status of the remaining 34 is unknown (Hill, 1999).

Whale watching is a major seasonal industry off California. For example, some 86,000 people participated in whale watch trips off Los Angeles, California, between 1996 and 1997. While whale watching guidelines have been established to protect whales from harassment, there is little enforcement.

Whales off California have also been subjected to the Acoustic Thermometry of Ocean Climate (ATOC) Program. The ATOC Program involved installing and periodically operating high-energy, low-frequency sound generators in deep waters on Pioneer Seamount off California to detect changes in ocean temperature, possibly indicative of global climate change. A marine mammal research component was added to the ATOC Program. Humpback (*megaptera navaeangliae*) and sperm (*Physeter macrocephalus*) whales both exhibited avoidance responses during ATOC transmission. Risso's dolphins (*Grampus griseus*) were also found farther from the source within 24 hours of the transmission. The results of the research program indicate that, although some changes in distribution and behavior of marine mammals were documented in the vicinity of the sound source off California, the changes were likely negligible (NRC, 2000). Because the Pioneer Seamount may be a critical habitat area for marine mammals, ATOC transmissions have been discontinued at this source.

Routine tankering operations (i.e., operational discharges, traffic and the potential for collision, noise) under the cumulative scenario are expected to occur at the same rate as for the proposed action. Effects of routine tanker operations are described in Section 4.3.4.3. The impacts of tanker operations on listed and nonlisted whales in the Pacific OCS Planning Areas under the cumulative scenario would be negligible.

Spilled oil may affect marine mammals through various pathways, as outlined in Section 4.3.4.3. Impact producing factors associated with a 7,800-bbl tanker spill or a 4,600-bbl pipeline spill include oil exposure and oil-spill cleanup activities. The total number of whales potentially affected by an oil spill would depend on the time of year and duration of the spill (i.e., seasonal migratory presence), the quantity of the spill, the density of the cetacean population in the vicinity of the spill, and the individual whale's ability to avoid the spill. Nearshore oil spills along the U.S. Pacific coast or within the Strait of Juan de Fuca have a higher potential to affect migrating gray whales and resident or migrant killer whales, as well as abundant dolphin and porpoise species of the region.

Conclusion: The overall cumulative impacts to whales from OCS and non-OCS activities including subsistence, commercial fishing, whale watching, noise, and pollution would be **minor**. While some mortality is expected, the level of mortality should not impact whale distribution or populations. If multiple large spills were to occur and contact cetaceans, the impact could be **minor to moderate**. The incremental contribution of the proposed 2002 OCS Program to the cumulative scenario is expected to be **minor**

4.8.4.3.2. Pinnipeds

Pinnipeds may be disturbed, harassed, injured, or killed (accidentally or deliberately) during fishing operations. Pinnipeds, in turn, may take or damage bait and fish caught on lines and damage fishing gear. Growing populations of California seals and sea lions may be threatening recovery of listed salmon species in Washington and Oregon. The MMPA (Section 120) authorizes State and Federal officials to kill California harbor seals and sea lions seen eating salmonids from stocks that are federally listed under the ESA if nonlethal deterrence methods have been determined to be ineffective or impractical. The State of Washington has applied for and received that authorization. Three sea lions were captured in the Ballard Locks area of Washington and removed to permanent captivity at Sea World in Orlando, Florida. Acoustic deterrents were used for an extended period of time before the sea lions' capture. Acoustic deterrents may damage pinniped hearing.

Shooting of Steller sea lions (*Eumetopias jubatus*) was thought to be a source of mortality before the species was listed as threatened under the ESA in 1990. Strandings of sea lions with gunshot wounds do still occur. From 1990 to 1997, the estimated minimum, annual mortality (in Washington, Oregon, and Alaska combined) of Steller sea lions was 2.8 sea lions per year. Live strandings and dead beach casts of California sea lions (*Zalophus californianus californianus*) have also been observed with gunshot wounds. The 1998 California Marine Mammal Stranding Network and the Oregon and Washington stranding databases show 70 mortalities and 8 injuries due to gunshot wounds.

Steller sea lions are also incidentally taken in three commercial fisheries: the California/Oregon thresher shark and swordfish drift gill net, the Washington/Oregon/California groundfish trawl, and the Northern Washington marine set gill net fisheries. The combined annual estimated mortality from these three fisheries from 1990 to 1998 is two Steller sea lions per year. Another estimated 0.2 animals per year are stranded due to entanglement in fishing gear. Estimates of fishing-related mortality reported by the USDOC, NMFS, are minimum estimates. The combined gunshot- and fishing-related mortalities are considered to have a minor impact on the Steller sea lion population. California sea lions are also taken incidentally to commercial drift and set gill net fisheries at an estimated annual rate of 158 sea lions per year. Additionally, fishing gear entanglement and hook and line fisheries caused California sea lion mortalities (17 and 24, respectively) and serious injuries (17 and 31, respectively) in 1998. Fishing related mortality in California sea lions is increasing and is no longer considered insignificant by NMFS.

Drift and set gill net fisheries may also cause incidental mortality of Guadalupe fur seals (*Arctocephalus townsendi*). No mortalities have been reported in California, and species-specific information is not available for Mexican fisheries. Juvenile female Guadalupe fur seals have stranded in central and northern California with signs of net abrasions around the neck, fish hooks, monofilament line, and polyfilament string. Other concerns for pinnipeds in California include reduced prey availability, contaminants, and disease. For example, many seals that died during disease outbreaks over the last several years have had high levels of environmental contaminants in their tissues. Viral infections were strongly implicated as the primary cause of these outbreaks. Relating the two, experimental animals chronically exposed to PCB's are known to have increased susceptibility to viral infections (Marine Mammal Commission, 1999). Premature pupping in California sea lions found in the Southern California Bight is possibly linked to PCB and DDT contamination (Marine Mammal Commission, 1999).

Impacts due to routine tankering operations (i.e., operational discharges, traffic, collisions, and noise) under the proposed action are discussed in Section 4.3.4.3. The same types of effects are expected under the cumulative scenario. Dredge disposal sites and municipal waste discharges occur close to shore and at considerable distances from favored pinniped haulout or breeding areas.

Oil spills may contact and affect pinnipeds (seals and sea lions) through several pathways (toxic stress, local displacement from preferred areas), as outlined in Section 4.3.4.3. A species' susceptibility to oil exposure is directly related to its presence (seasonal or resident), range and preferred habitat (e.g., shelf/slope waters vs. nearshore coastal), life history (e.g., remains at sea, only returns to land to breed and molt vs. use of established haulouts), and spill location and transport. Oil spills (from tankers) in northern California and Oregon that contact Steller sea lions, their rookeries, haulout areas, or primary prey represent the greatest potential for impact to this species. Cumulative spills near the Channel Islands, where Guadalupe fur seals are rare seasonal visitors, present less potential for impact due to the limited presence of this species in the area, as discussed in Section 4.3.4.3. Offshore spills in deep water are most likely to affect those species that utilize these waters (e.g., northern elephant seal).

Conclusion: Overall cumulative impacts to pinnipeds from OCS and non-OCS activities would be **minor**. The impacts of multiple large oil spills and spill response activities to pinnipeds under the cumulative scenario could range from **minor to moderate**. The incremental impacts to pinnipeds from the proposed action, relative to OCS and non-OCS activities, would be **negligible**.

4.8.4.3.3. Fissipeds

Since protection was provided to sea otters (*Enhydra lutra neries*) in 1911 (under the North Pacific Fur Seal Convention), they have recolonized or have been reintroduced into much of their historic range (Section 3.3.2.1). In the last 20 years, however, new threats emerged such as entanglement in fishing gear, chemical pollution, new and unusual diseases, oil spills, and oil and gas activities. As discussed in Section 3.3.2.1, the California sea otter population appears to have been declining since 1995. The cause of the decline is not known but could include contaminants and increased susceptibility to disease as a result of immune suppression associated with contaminants. Postmortem analyses of beach cast sea otter carcasses have documented the presence of potentially harmful levels of DDT derivatives, butyltin, and other anthropogenic contaminants that may be adversely affecting the California sea otter population (Marine Mammal Commission, 2000b).

Substantial numbers of sea otters caught and incidentally killed in the coastal gill and trammel net fisheries were thought to reverse population increases realized after listing the sea otter under the ESA in 1977. Commercial fishing prohibitions substantially reduced sea otter incidental take and contributed to resumed sea otter population growth.

Impacts to southern sea otters due to routine tankering operations (i.e., operational discharges, traffic and the potential for collision, noise) under the proposed action, as discussed in Section 4.3.4.3, are minimal. Under the cumulative scenario, OCS and non-OCS routine operations are expected to have the same minimal or minor impact.

Southern sea otters rely solely on their fur for insulation (as with fur seals) and regularly groom themselves to maintain proper insulation. For these reasons, the species is highly vulnerable to direct oil contamination. Short- and long-term effects of an oil spill on southern sea otters are discussed in Section 4.3.4.3. Single or multiple spills occurring offshore the southern sea otter range represent a serious threat to this population, while cumulative spills occurring elsewhere in the Pacific Region are not as significant. The 1989 *Exxon Valdez* oil spill in Prince William Sound, Alaska, demonstrated that a single oil spill could affect an area larger than the current California sea otter range. This prompted the FWS to abandon its sea otter zonal management concept and recognize that sea otters should be allowed to naturally recolonize their former range, both north and south of their current range in California. Spills from OCS and non-OCS sources are mitigated to some degree by oil-spill response activities, which may also disturb or displace fissipeds.

Conclusion: The overall cumulative impacts to sea otters from all sources would be **moderate**. If large spills were to contact fissipeds, impacts could range from **negligible** (anywhere along the U.S. west coast, except off central California) to **moderate** (offshore central California). The incremental contribution of the proposed action to the cumulative impacts would be **negligible**.

4.8.4.4. Marine and Coastal Birds

Impacts to all marine and coastal birds in California result from habitat destruction, predation, and disease. In the case of the western snowy plover (*Charadrius alexandrius nivosus*), the most important form of habitat loss to coastal breeding birds has been encroachment of the nonnative European beach grass (*Ammophila arenaria*), reducing the amount of nesting habitat. Other factors responsible for adverse impacts to coastal nesting habitat include human activity such as walking, jogging, running pets, horseback riding, off-road vehicle use, and beachraking. After the 1989 earthquake virtually eliminated beach access, western snowy plover fledgling success increased 16 percent at Moss Landing Beach (Page, 1990). Avian and mammalian predation is also a major concern at nesting sites. Crows, ravens, and red fox have had a significant adverse effect on reproductive success of several nesting colonies. Similarly, California least tern (*Sterna antillarum browni*) nesting and foraging sites are subject to destruction and degradation. Reduced nesting habitat has resulted in isolated colonies that are vulnerable to predation from native, feral, and exotic species; overwash by high tides; and vandalism and harassment by beach users.

Habitat protection and restoration remain a major component of listed marine and coastal bird recovery plans. For example, the proposal to designate Guadalupe-Nipomo Dunes as a National Wildlife Refuge along 18 miles of the central California coast in Santa Barbara and San Luis Obispo Counties will help restore and protect habitat for the western snowy plover, the California least tern, and the California brown pelican.

Unusual avian mortality events occurred in 1996, 1997, and 1998, infecting and killing thousands of listed and nonlisted birds. The most recent massive bird die-off, which began in December 1997, affected mainly waterfowl (primarily grebes, ducks, and cormorants), and resulted in 18,400 bird deaths in the Salton Sea. The death causing diseases were identified as avian cholera, avian botulism, Newcastle disease, and salmonella. Over 120 California brown pelicans (*Pelicanus occidentalis californicus*) died between December 1997 and October 1998. Over 6,000 cormorants, 4,000 ruddy ducks, and 3,000 grebes also died in the same time period.

California brown pelican population size and productivity naturally oscillate in response to natural environmental changes. These changes have historically been related to cyclical water temperature changes off southern California, which are expected to continue in the future and be responsible for major fluctuations in pelican population size.

Routine tanker vessel traffic and associated discharges under the proposed action are not expected to produce measurable impacts to either seabirds or shorebirds of the Pacific Region. None of the routine operations associated with the cumulative scenario activities have the potential to seriously affect threatened or endangered marine and coastal birds unless their operations occur near favored coastal nesting habitat. Similarly, impacts resulting from routine tankering (i.e., operational discharges, traffic and the potential for collision, noise) under the cumulative scenario would be minimal for nonlisted marine and coastal birds.

As discussed in Section 4.3.4.4, oil spills have the potential to directly affect listed and nonlisted seabirds through oil ingestion; fouling of feathers, habitat, or prey; and localized displacement from preferred areas (during spill cleanup operations). Effects of a 7,800-bbl tanker spill along the west coast to coastal and marine birds could be long term and wide ranging, depending upon the spill location, season, and local current and wind conditions, as well as oil-spill response, cleanup, and containment successes. As was noted for marine mammals, the susceptibility of a listed bird species to oil exposure is directly related to its presence (seasonal or resident), range and preferred habitat (e.g., shelf/slope waters vs. nearshore coastal), and life history, as well as spill location and transport. Nearshore spills, such as a 4,600-bbl pipeline spill, would likely affect the vast majority of listed avian species, because nearshore coastal waters are preferred foraging habitat. In general, the impact summary and impact determination presented for listed avian species would be applicable to nonlisted marine and coastal birds. Based on assumptions stated previously and the analysis of oil-spill effects in Section 4.3.4.4, the impacts resulting from oil spills in the cumulative scenario (Table 4-6c) are estimated to produce minor to moderate impacts to marine and coastal birds.

Conclusion: Overall cumulative impacts on marine and coastal bird populations from all sources, natural and human related, could be **minor to moderate**. The impact to marine and coastal birds from large oil spills is estimated to range from **minor to moderate**, depending on spill size and location. The incremental contribution to cumulative impacts of routine OCS tanker operations would be **negligible**.

4.8.4.5. Fish Resources

Routine discharges from transiting tankers are unlikely to affect any fish species of the Pacific Region (i.e., soft and hard bottom, demersal, midwater, coastal pelagic, epipelagic, and highly migratory fishes) due to dilution, as discussed in Section 4.3.4.5. Routine operations of OCS cumulative activities are not likely to adversely affect fish resources.

Dredging and marine disposal activities, along with the associated increases in turbidity, could cause the temporary relocation and disruption of feeding behavior of adult soft-bottom fishes. Localized impacts to fishes located near municipal waste discharges (i.e., sewage outfalls in southern California) could occur.

Impacts from oil exposure vary between fish groups and life stages, as detailed in Section 4.3.4.5. Further, while spill response and mechanical cleanup activities are not expected to adversely affect any fish resources, the possible use of dispersants has the potential to adversely affect eggs, larvae, juvenile, and adult forms that occur at or near the ocean surface.

The OCS cumulative scenario (Table 4-6c) assumes two 7,800-bbl spills from tankers carrying Arctic OCS production and a 4,600-bbl pipeline spill in the Pacific Region. Large oil spills in deep water would produce minor impacts to fish resources of the region (Section 4.3.4.5). Fish could be expected to recover fully from such spills. Under the cumulative scenario, fish resources in the Pacific Region could be affected by as many as three oil spills from tankers carrying Alaska North Slope oil from Valdez and as many as five spills from import tankers. Effects of these spills would be similar to those previously described in Section 4.3.4.5.

Conclusions: The cumulative impacts to fish resources in the Pacific Region associated with non-OCS activities would be **negligible**. The cumulative impact from large spills of Federal OCS, State and imported oil would be **minor**. Localized coastal impacts could be more severe. The incremental impacts from the 2002 OCS Program are expected to be **negligible** to **minor**.

4.8.4.6. Sea Turtles

As noted in Section 3.3.2.4, the presence of the four species of sea turtle (i.e., green, leatherback, loggerhead, and Pacific ridley), known to frequent waters of the Pacific Region, is considered uncommon. Leatherbacks are most likely to be sighted in the Pacific Region, with preference for deeper shelf and slope waters.

Sea turtle populations in the eastern Pacific Ocean have been greatly reduced by overharvesting and, to a lesser extent, coastal development of nesting beaches in Mexico and Central America (Ross, 1982). Overharvesting and coastal development of nesting beaches will probably continue to be the major threats to these populations.

While tanker discharges from routine OCS activities under the proposed action include components that may injure sea turtles, impacts are minimized via rapid dilution and dispersal, as discussed in Section 4.3.4.6. For similar reasons, routine OCS and non-OCS tanker operations under the cumulative scenario are not likely to adversely affect marine turtles.

Spilled oil, should it contact sea turtles, may affect sea turtles through various pathways, as discussed in Section 4.3.4.6. The OCS cumulative scenario assumes some tanker and pipeline spills of crude oil in the Pacific Region (Table 4-6c). Non-OCS activities also represent potential sources of small to large spills of crude oil or refined petroleum products (e.g., loss of crude oil via import tanker accident, loss of diesel or fuel oil via cargo vessel accident). Oil spills from OCS or non-OCS vessel collisions could occur anywhere on the OCS or in State waters near major ports.

Conclusion: Overall, the impacts to sea turtle populations from OCS and non-OCS routine activities are expected to be **moderate**. If large oil spills on marine and coastal bird populations contact sea turtles, they could cause **minor to moderate** impacts; however, large spills would likely have only **negligible** impacts at the population level. The incremental impacts of the proposed action on sea turtles would be **negligible**.

4.8.4.7. Coastal Habitats

4.8.4.7.1. Wetlands and Estuaries

Factors that may produce cumulative effects on estuaries in the Pacific Region include both non-OCS and OCS-related activities. Major sources of non-OCS oil and gas cumulative impacts to estuaries in U.S. waters include increases in urban development, municipal and industrial discharges, and Alaskan and foreign-import tankering.

The loss of estuarine habitat, particularly in southern California, has been staggering. According to Zedler (pers. commun., 1991), 91 percent of the original estuarine habitat of southern California has been lost. Even if all development were to stop today, the process of continued estuary loss, having been set in motion, will not stop. Many anthropogenic processes are involved in this loss, but the greatest cause is development involving filling in of estuaries so structures can be constructed. Although policies, such as No Net Loss of Wetlands, have been implemented, the continued loss of estuarine habitat by urban development can be assumed, although at a lower rate than in the past.

Next to development, domestic and industrial sewage may cause the greatest effect on estuaries. Impacts are greatest near large metropolitan areas such as Puget Sound, San Francisco Bay, and, particularly, the Los Angeles-San Diego area. An estimated 1.34 billion gallons of treated municipal sewage per day are discharged into the waters off southern California (Southern California Coastal Water Research Project [SCCWRP], 1990). Most of the estuarine habitat in southern California has already been severely altered, much of it possibly beyond repair. Although most of the wastewater does not flow directly into estuaries, it affects estuaries directly as well as indirectly by having polluted water as part of the environment.

It is assumed that exploration, development, and production will occur on a few active leases in the Southern California Planning Area. No such activity is assumed for central and northern California, Oregon, or Washington. Routine discharges from transiting tankers are unlikely to affect wetlands and estuaries of the Pacific Region, as discussed in Section 4.3.4.6. Similarly, routine OCS operations are not likely to adversely affect wetlands and estuaries (e.g., due to dilution of discharges and distance of wetlands and estuaries from tankering routes). The contribution of tanker traffic to the cumulative impacts to Pacific Coast wetlands and estuaries would be negligible.

Three possible sources of accidental oil spills must be considered. Two of these, the tankering of Alaskan-produced oil through the TAPS system and the tankering of imported foreign oil, are non-OCS activities and will occur with or without implementation of the proposed program. If the proposed program were implemented, OCS oil could be added to the tankering from Alaska. Finally, activity off the coast of California could result in spills from production facilities or transportation.

Impacts to wetlands and estuaries from a 7,800-bbl tanker spill could only be expected under certain conditions. Offshore spills are not likely to affect wetlands and estuaries due to distance from shore and physical processes (i.e., oil weathering removes the toxic fractions). Tankers entering port, however, have the greatest potential to adversely affect local wetland or estuarine environments (e.g., Puget Sound, San Francisco Bay), as discussed in Section 4.3.4.6. Once oil enters a wetland or estuarine environment, plants and animals are oiled, and subsequent cleanup operations would be damaging.

The impacts of an oil spill entering an estuary and remaining for several tidal cycles could include destruction of a major part of the local community, either of the entire estuary or those portions where oil soaked into the sediments. Recovery could require 5 to 10 years. Local impacts would be greatest in southern California, due to the scarcity of relatively pristine estuaries in that region. Regional impacts could involve a decrease of several populations in local estuarine communities, but with no real interference with ecological relationships in the region.

Estuarine habitat will probably continue to decrease in the Pacific Region, particularly in the populated areas of California, for the next 25-40 years. The primary cause of the decline will continue to be urban development and, to a lesser extent, domestic and industrial pollution. For the most part, impacts from oil spills should not be discernible from normal community population fluctuations within the Pacific Region. In southern California, where relatively unaltered estuaries are rare, contact by an oil spill could destroy major components of the affected estuarine community for up to 10 years. Similar, local impacts could occur in central and northern California, Oregon, and Washington.

Conclusion: The overall cumulative impact to Pacific Coast wetlands and estuaries would be **major**. The incremental impact a single 7,800-bbl spill from the 2002 OCS Program would be **negligible** for the majority of wetlands and estuaries along the U.S. west coast. However, for those resources located near major tanker ports, such incremental impacts could range from **minor** to **moderate**.

4.8.4.7.2. Intertidal Benthos

Routine discharges from transiting tankers are unlikely to affect intertidal benthos of the Pacific Region, as discussed in Section 4.3.4.7.2. Similarly, routine operations of OCS and non-OCS cumulative activities are not likely to adversely affect the intertidal zone (e.g., due to dilution of discharges). Therefore, incremental impacts of tanker operations under the proposed action (relative to OCS and non-OCS cumulative activities) would be negligible.

The accidental release of 7,800 bbl of oil could have an impact upon intertidal benthos, depending upon spill location, degree of weathering, efficiency of spill response and containment, and oceanographic conditions, as discussed in Section 4.3.4.7.2. While individual or cumulative spills occurring far offshore are estimated to produce negligible impacts to intertidal benthos, nearshore spills (e.g., when a tanker heads into port) offer greater risk of impact to intertidal benthic communities. As noted previously, OCS and non-OCS cumulative accident scenarios include the potential for minor to major oil releases (i.e., 7,800-bbl spill from OCS cumulative activities; minor to major spills from non-OCS sources such as vessel collision), all of which may also adversely affect intertidal benthos under certain conditions (i.e., nearshore spills, transport towards shore).

Based on assumptions stated previously, the incremental impact of a single 7,800 bbl spill under the proposed action would be negligible for the majority of intertidal benthos along the U.S. west coast. For those intertidal areas located near major tanker ports, such incremental impacts are estimated to range from negligible to moderate.

Conclusion: Cumulative impacts of routine activities associated with tanker operations would be **negligible**. The overall cumulative impact from large oil spills would be **negligible** to **moderate.** The incremental impact of routine activities assumed under the proposed action would be **negligible**. Incremental impacts of oil spills assumed for the proposed action would be **negligible** for the majority of intertidal benthos along the U.S. west coast, but they would range up to **moderate** for those intertidal areas located near major tanker ports.

4.8.4.8. Areas of Special Concern

4.8.4.8.1. Essential Fish Habitat

There are several routine operations that may have a cumulative impact on EFH in the Pacific Region. There are 23 oil and gas production facilities in Federal waters off the coast of California. All 23 facilities are currently operating under individual or general NPDES permits that have been administratively extended.

Commercial and recreational fishing could have effects on EFH. Many types of benthic fishing activities such as trawls and dredges could damage or destroy bottom EFH. Some species are more heavily fished, and the resulting reduction in these fish may change the immediate ecosystem. Physical changes to the seafloor would include leveling of rock formations, resuspending sediments, and removal of submerged aquatic vegetation. Longline gear may remove plants, corals, and other sessile animals. Pot gear may damage demersal plants and animals as it settles, and longlined pots being dragged as they are retrieved may damage bottom fauna.

Midwater trawling may affect EFH in the water column. There is a large midwater trawl fishery for Pacific whiting north of 42^{o} N. longitude. Prolonged offal discards from some large-scale fisheries have redistributed prey away from midwater and bottom feeding organisms to surface-feeding organisms, usually resulting in scavenger and seabird population increases (Hill and Wassenberg, 1990; Evans et al, 1994).

Dredging of navigable waters to create deepwater channels for shipping purposes would have impacts on benthic EFH. In the process of dredging, excessive quantities of seafloor are removed, disturbed, and resuspended. Turbidity plumes may also arise, diminishing EFH water quality.

Water intake structures may withdraw larval and postlarval fish species. Freshwater withdrawal also reduces the volume and possibly the timing of freshwater reaching estuarine environments, potentially altering circulation patterns, salinity, and the upstream migration of the saltwater wedge.

Aquaculture activities may reduce or degrade habitats used by native stocks. Aquaculture operations may discharge organic waste and/or antibiotics into the marine environment. The release of these wastes may introduce nutrients or organic materials into the surrounding water body and lead to a high biochemical oxygen demand, which may reduce dissolved oxygen and potentially reduce the survival of many aquatic organisms in the area.

Two tanker spills (7,800 bbl) of oil from Arctic OCS production off the west coast in the Pacific Region and one pipeline spill (4,600 bbl) from southern California OCS production are assumed under the cumulative scenario. Additionally, three large tanker spills (7,800 bbl) from Alaska and North Slope oil production and five large oil spills from import tankers are also assumed. Regardless of where these spills occur—in offshore shipping lanes, on the continental slope, on the continental shelf or inside State waters in preparation for docking—surface oil will come into contact with EFH of many of the 83 managed species. Surface waters are used as habitat for pelagic eggs, larvae, and spawning activities of many of the managed fish species. Depending on the time of year, pelagic eggs and larvae may be concentrated within an oiled area and be unable to escape the oil. Under some conditions, tar balls may form and settle to the benthic environment and may be ingested by bottom feeding fish, thus injuring or killing these fish.

Conclusion: The overall cumulative impact from routine activities would be **minor** to **moderate.** The loss of benthic EFH primarily by fishing trawls and longline pot gear may have serious effects on managed fish species. The overall cumulative impact of large spills would be **minor** to **moderate.** Spills occurring near shore would have more and longer lasting impacts on coastal EFH used as spawning and nursery grounds for managed fish species. The incremental impacts from the 2002 OCS Program would be **negligible**.

4.8.4.8.2. National Marine Sanctuaries

Major pollution issues in the Gulf of the Farallones National Marine Sanctuary are sewage, toxic chemicals, petroleum products, pesticides, and urban runoff. In the Monterey Bay National Marine Sanctuary, resource management issues include vessel traffic, dredge material disposal, urban runoff, fishing, and invasive species. Similarly, the Channel Islands National Marine Sanctuary issues are busy shipping lanes, nonpoint source pollution, commercial and recreational fishing, and oil and gas development. Storm water runoff in El Niño years (most recently 1998) inundates sanctuary waters with freshwater, terrestrial sediments, agricultural runoff, and other debris. The runoff can change light conditions in the water and enhance nutrients, resulting in algal blooms. The impacts of these major storm events are not completely understood.

As discussed in Section 4.3.4.8.2, oil spills have the potential to directly affect surface waters and biological resources (birds, marine mammals) present within the sanctuary via water quality degradation, direct oil contact, and fouling of habitat. Effects of spills to sanctuary resources could be long term and wide ranging, depending upon the spill location, season, and local current and wind conditions, as well as oil-spill response, cleanup, and containment successes. The susceptibility of a marine mammal (Section 4.3.4.3) or bird (Section 4.3.4.4) species to oil exposure is directly related to its presence (seasonal or resident), range and preferred habitat (e.g., shelf/slope waters vs. nearshore coastal), and life history, as well as spill location and transport. Offshore spills in the vicinity of several insular Pacific Region sanctuaries (e.g., Channel Islands, Gulf of the Farallones) may be more damaging than those located along the mainland coast.

The cumulative oil-spill scenario assumes the potential for major oil spills from tankers transporting crude production (from OCS Alaska, North Slope production, and imported oil), and a pipeline spill (from southern California OCS production). These spills may adversely affect marine sanctuaries if they were to occur in the same general location and were carried into a sanctuary. Based on assumptions stated previously, the incremental impacts resulting from large oil spills under the proposed action are estimated to produce minor to moderate impacts to marine sanctuaries, depending upon whether multiple spills of sufficient size reach sanctuary waters.

Conclusion: Overall, cumulative impacts to national marine sanctuaries on the Pacific Coast would be **minor**, except during El Niño years when impacts could be **moderate**. Impacts resulting from large oil spills from all sources under the cumulative scenario are estimated to produce **minor to moderate** impacts to marine sanctuaries, depending upon whether multiple spills of sufficient size reach sanctuary waters. The incremental impacts to sanctuaries from the proposed 2002-2007 OCS Program would be **negligible**.

4.8.4.8.3. National Parks, Refuges, and Reserves

Routine discharges from tankers in transit are unlikely to affect national parks, national wildlife refuges, national estuarine research reserves, or California Areas of Special Concern in the Pacific Region (due to dilution of discharges). Urban, commercial, and industrial development along the coast, though excluded from these resources, could alter the nature of the landscape surrounding them, making them less useful as parks, refuges, or reserves. Most offshore activities such as dredging, ocean disposal or State oil and gas operations are likewise not permitted in or near these resources and are not likely to adversely affect them. Therefore, incremental impacts of tanker routine operations resulting from the proposed action would be negligible.

Transportation of oil to west coast ports could result in spills anywhere along the transportation route. Based on quantities of oil imported in the past and shipments of Alaska onshore production, as many as eight tanker spills might take place under the cumulative scenario. Only one spill is estimated to result from Alaska OCS activity and one from ongoing OCS production offshore Southern California based on anticipated production.

Oil spills from imports, tankers carrying Alaska onshore oil, and OCS production have the potential to directly affect coastal portions of several areas of concern through degradation of coastal surface waters and direct effects to biological resources (e.g., birds, marine mammals) that may be present. These areas include national parks such as Redwood National Park, Point Reyes National Seashore, and the Channel Islands National Park; national wildlife refuges such as Grays Harbor in Washington, Oregon Islands in Oregon, Humboldt Bay and the Farallon Islands refuges in California; national estuarine research reserves such as Padilla Bay in Washington, South Slough Oregon, Humboldt Bay or Elkhorn Slough in California; and California Areas of Special Concerns.

Effects of spills to these areas could be long term and wide ranging, depending upon the spill location, season, and local current and wind conditions, as well as oil-spill response, cleanup, and containment success. Oil spills under the cumulative scenario could produce negligible to moderate impacts to all these areas of concern; however, the contributions of the proposed action to cumulative impacts would be negligible.

Conclusion: Cumulative impacts to areas of special concern along the Pacific Coast could be **negligible** to **moderate**, and the contribution of tankering OCS oil from Alaska to those impact levels is expected to be **negligible**. The incremental contribution of the 2002 OCS Program is expected to be **negligible.**

4.8.4.9. Fisheries

4.8.4.9.1. Commercial Fisheries

Tankering of oil from Alaska will occur along the Pacific Coast. Effects of their routine operations on commercial fisheries will include vessel noise, discharges, and marine navigational right of ways. Through radio communications between vessels, any conflicts should be avoided.

Noise from tankers may temporarily scatter fish targeted by commercial fishers. This may increase fishing vessel cruise time and reduce their catch per tow. However, most groundfish have a homing range and will return once the vessel leaves the area. Large pelagic species may move on and not return to the area. Commercial fishing vessels tend to follow the migrations of these pelagics so they will most likely quickly relocate the fish.

Major sources of decline in commercial fisheries will include competition for resources, space within the industry, recreational fishing pressure, coastal development, and domestic and industrial pollution near large metropolitan areas (e.g., Los Angeles and San Francisco).

The size of the commercial fishing fleet and the available amount allowable for harvest impact commercial fishing. Fishing pressure has increased on some species as populations sizes have decreased on others. Regulations governing the total allowable tonnage and time and area closures have been enacted in an effort to prevent the collapse of many of these commercially important species.

Competition may occur among members of the same fishery for limited resources, as well as among commercial fisheries for fishing space. Limited entry restrictions on currently unlimited fisheries will act to reduce competition levels somewhat, but at the same time may limit opportunities for fishermen to switch gears. Less traditional fisheries such as mariculture operations may limit access to prime nearshore fishing grounds (e.g., in the Santa Barbara Channel). As cost/benefit ratios increase and solutions to nearshore coastal pollution are found, the amount of area occupied by mariculture operations may be expected to increase, although this is not expected to have substantial regional effects.

Commercial fishing gear has varied effects on fish habitat and ultimately may reduce the available population of commercially important fish. Trawl gear may drag along the bottom and into the sediments as much as 30 cm, damaging or destroying habitat and food sources for commercially targeted species. In the past, trawl gear has been nonselective and has picked up by-catch including juvenile fish of commercially targeted species. This can result in a large loss of future year classes of these species.

Seine nets (or gill nets) and trammel nets, which are only used south of 38^{o} N. latitude, are also known to ghost fish (Pacific Fisheries Management Council [PFMC], 1997). These nets have been observed entangling fish, seabirds, mammals, crabs, and other invertebrates (High, 1998).

Competition among domestic commercial fishermen and sport anglers for limited resources and access to fishing grounds already exists and is expected to intensify as resources are further diminished. Fishing pressures are expected to remain high as demand for species favored by both sport and commercial fishermen increases, sportfishing populations grow, and commercial fishing practices become increasingly efficient. Occasionally, access to traditional fishing grounds (e.g., set gill net fisheries) is limited by projects designed to enhance sportfishing opportunities (e.g., placement of artificial reefs).

Impacts from municipal and industrial wastewater discharges and other offshore effluent in southern California are greatest near large metropolitan areas, particularly the Los Angeles-San Diego area. An estimated 1.34 billion gallons of treated municipal sewage per day are discharged into the waters off southern California (SCCWRP, 1990). Greater strides will be made to decrease or at least limit the amount of sewage entering the southern California region; however, with a projected 50-percent increase in the coastal population by the year 2010, pollution and its effect on southern California fish will remain at its present level over the next 25-40 years. The reduction of fishery stock due to pollution and possible overfishing could lead to reduction of commercial fisheries over the next 25-40 years, particularly in the southern California area.

Multiple-use conflicts are likely to occur between commercial fishermen and the military, as well as between commercial fishermen and oil and gas industries. Most military maneuvers normally occur offshore and within recognized zones; thus, spatial preemption of fishermen during military activities is fairly localized and short term, lasting a few days to weeks. In contrast, oil and gas structures are a continuing presence on the OCS, preempting primarily commercial trawl fishermen, as well as fishing areas used by drift gill net and purse seine fisheries.

Two OCS tanker spills (7,800 bbl each) and one OCS pipeline spill (4,600 bbl) are assumed to occur in the cumulative case scenario in the Pacific Region. Large oil spills can have significant impacts on commercial fisheries. If a spill were to occur on major fishing grounds, there would be area closures to prevent the possible take of contaminated fish. If the oil were to reach shallow coastal areas or kelp beds, the closures could last the entire season. Oiled kelp plants would be unavailable for commercial harvest, and fish and invertebrate habitat would be diminished. Diminished harvest would result in economic losses for the affected commercial fisheries. Public perception of the effects of spills on fish could also reduce consumer demand for Pacific coast fish, which would reduce economic benefit to the affected commercial fisheries. Coastal spills may oil shallow habitat which serves as spawning and nursery grounds for many commercially important fish species. Loss of juveniles and habitat may negatively affect the population size of the affected year class once the fish reach harvestable size.

In addition to the OCS spills, three tanker spills (7,800 bbl each) from oil production from the State of Alaska waters (Arctic) and the North Slope and five spills from import tankers (7,800 bbl each) are assumed to occur under the cumulative scenario. These additional spills will add to the impacts caused by OCS spills on commercial fisheries. These impacts include reduced fish harvest, area fishing grounds closures, reduction in available habitat, reduced numbers of adults in the affected juvenile year class, and reduced consumer demand for fish.

Locally, more than half of the combined landed value to ports within the Santa Barbara region is composed of sea urchin, abalone, lobster, and crab harvested by fixed gear fishermen and commercial divers. If catches were reduced as a result of an oil spill, the subregion could experience a number of impacts, including high economic losses and increased unemployment among fixed-gear fishermen.

If an oil spill were to contact important fishing areas and taint fisheries resources or contaminate fishing gear, fishermen could be expected to sustain economic losses for about 1 month or as long as it takes to clean their gear. If a large oil spill were to contact a fishing port and fishermen were prevented from leaving port by oil containment booms, fishermen could sustain complete economic losses during the period that the booms are in place (about 1 month). The consequences of an oil spill to the regional fishing industry would be most severe if oil were to contact Los Angeles and Long Beach Harbors and port closure were to result. Since these harbors receive the bulk of commercial fish landings for southern California, a reduction in activity could have repercussions on local, regional, and Statewide levels. Overall, however, oil-spill impacts on commercial fisheries are not expected to be discernible from normal fluctuations of commercial fisheries within the Pacific Region.

Conclusion: Cumulative impacts to commercial fisheries from non-OCS routine activities are expected to be **moderate** to **major**. Cumulative impacts of large oil spills on fisheries may be **moderate** to **major** depending on time of year and actual spill locations. The extent to which the 2002 OCS Program would contribute to the overall cumulative impacts would range from **minor** to **moderate**.

4.8.4.9.2. Recreational Fisheries

Routine OCS tankering activities should have little impact on recreational fisheries. Tanker noise and routine discharges may temporarily scatter some fish, but most fish will return to their established habitat. Recreational vessels will want to avoid tanker traffic and ship wake, but through vessel-to-vessel radio communications, this should not pose a problem.

Non-OCS routine activities having cumulative effects on recreational fisheries in the Pacific Region include competition between other recreational and commercial fisheries, industrial and domestic sewage, Los Angeles/Long Beach Harbors (2020) expansion project, and Alaskan and foreign-import tankering.

Of these factors, increased fishing pressure from commercial and recreational fishermen is expected to contribute most to man-induced stresses on fish resources. Fishing pressures are expected to remain high as demand for favored species by both sport and commercial fishermen increases, fishing practices become increasingly efficient, and participation in sportfishing accelerates as a function of coastal population growth. These activities would result in declines in some fish stocks and ever increasing competition among sport and commercial fishermen for remaining stocks.

Increased vessel traffic associated with growth of urban centers and redevelopment and expansion of the Los Angeles Harbor and San Francisco would affect sportfishermen because of harbor congestion, increased competition for docking space, increased risk to navigation, and crowding at and near various marinas. Eventually berthing, port, wharf, and marina space is expected to expand along with planned industrial developments.

Tainting of resources and/or subsequent fear of contamination may result from a variety of activities. Increased levels of contaminants are associated with chronic exposure to discharges from publicly/privately-owned vessels, municipal sewage treatment plants, urban runoff, harbor flushing, and natural oil seeps. Impacts would be greatest near large metropolitan areas such as Puget Sound, San Francisco Bay, and, particularly, the Los Angeles-San Diego area. An estimated 1.34 billion gallons of treated municipal sewage per day are discharged into the waters off southern California (SCCWRP, 1990). Greater strides will be made to decrease or at least limit the amount of sewage entering the southern California region.

Oil spills could occur anywhere on the OCS or in State waters near major ports. Oil spills tend to preclude all sportfishing in the affected area until cleanup or dispersion of oil occurs. A large tanker spill could result in the loss of fish and invertebrate resources, decreased resource accessibility, and possibly reduced desirability of fish and invertebrates through tainting in all areas of the Pacific Region. However, the mobility of the party and private vessel sportfishing fleet would facilitate avoidance of affected areas and lessen the impacts from possible reductions in available catch, possible capture of tainted fish, and contamination of gear. Oil-spill contacts to the shoreline or offshore islands in southern California (i.e., Channel Islands) would have important impacts on shore fishermen and sport divers. Fishing and diving activities would be halted until after cleanup operations were completed or the spill had been dispersed by wind and wave action.

If an oil spill were to contact a harbor anywhere in the Pacific Region where sport boat operations concentrate, operators of commercial passenger fishing vessels and skiff rental facilities might sustain local temporary (about 1 month) economic losses (10-20 percent). These losses could be attributable to any or all of the following factors: adverse publicity keeping fishermen away from the affected area; vessel confinement to port by oil containment booms; or inability to shift fishing operations outside the immediate vicinity of the spill. Economic impacts would be greatest in southern

California in areas of highest party/charter boat activity, including Santa Barbara Harbor, Ventura Harbor, Channel Islands Harbor (Oxnard), Port Hueneme, and possibly as far south as Los Angeles Harbor. Regionally, economic costs of oil spills to the sportfishing industry of oil spills are expected to be minimal, having no discernible economic impact due to the large area involved and the number of harbors that would likely be unaffected by a spill.

The synergistic effects of chronic pollutants from expanding marine-related industries and urban development and increasing competition among a growing sportfishing population and existing commercial fishing industries for the most desirable target species are likely to have an adverse effect on catch rates. As a result, the quality of the recreational fishing experience is expected to deteriorate with time. As public awareness of the problem grows, adverse effects may be partially offset by improved management of marine fishery resources, stock enhancement programs, installation of artificial reefs, and improved control and abatement of chronic pollution as public awareness of the problem grows. Although difficult to predict, natural environmental factors would also likely contribute to long-term changes in resources available to sportfishermen, and vagaries of outside economic forces (e.g., recession and fuel shortages) would influence future participation.

Conclusion: Cumulative impacts from routine activities on recreational fishing are expected to be **moderate** to **major**. Cumulative impacts of large oil spills on fisheries could be **moderate** to **major** depending on time of year and actual spill locations. The extent to which the 2002 OCS Program contributes to the overall cumulative impacts would range from **minor** to **moderate**.

4.8.4.10. Tourism and Recreation

There is considerable commercial vessel traffic in designated shipping lanes off the Pacific coast. Some of this traffic consists of tankers transporting approximately 14 million metric tons of oil from Asia and around 25 million metric tons of oil from onshore Alaska, transshipped through the port of Valdez. Emissions and discharges from most of the traffic are not visible or detectable from recreational areas on shore. The addition of tankers containing crude oil resulting from development on the OCS off Alaska from this proposed action would not cause a noticeable change in vessel traffic or discharge levels apparent to users of recreation sites along the coast.

Maritime accidents resulting in oil spills are the primary concern in terms of recreation sites along the coast and tourism relying on the attraction of the coastline. Based on past volumes of oil imported to west coast ports, and assuming the rate of tanker accidents remains the same, as many as three oil spills from tankers moving Alaska North Slope oil to western ports could take place, and as many as five oil spills from tankers importing oil could occur (Table 4-6c). Oil from future OCS activity in Alaska could result in two additional tanker spills along the west coast. It is unlikely that the proposed action would add measurably to the risk of spills contacting recreation sites or affecting tourism. The pressures of increased population with accompanying demands on water use, increased production of effluents, and air emissions from vehicles used to travel to and from recreation sites and tourist attractions would place a strain on recreational areas and tourism along the west coast which would be aggravated by the presence of spilled oil on beaches. The incremental increase in these impacts resulting from the proposed action would be negligible.

Conclusion: The cumulative impact from routine activities to tourism and recreation areas along the west coast would be **negligible**. If large spills were to occur and contact a recreation area or tourist destination, impacts could be **moderate**; however, the contribution of Alaskan OCS tankers would be **minor**.

4.8.4.11. Sociocultural Systems and Environmental Justice

Routine discharges from transiting tankers are unlikely to affect sociocultural systems of the Pacific Region, as discussed in Section 4.3.4.11. Similarly, routine operations of OCS and non-OCS activities are not likely to adversely affect sociocultural systems.

The cumulative accident scenario, described previously, include spills from OCS and non-OCS sources that could occur anywhere on the Pacific OCS or in State waters near major ports. Impacts of oil spills on sociocultural systems can vary considerably depending upon the total volume of oil reaching land and the sensitivity of sociocultural systems to oil impacts, as outlined in Section 4.3.4.13. Sociocultural systems at greatest risk are those that are most closely tied to the marine environment. In a general approach, cumulative sociocultural impacts would be similar to those noted for other socioeconomic components considered previously—population, employment, regional income, land use, and exiting infrastructure. However, certain communities (e.g.., Makah tribe of Neah Bay, Olympic Peninsula) are considered at greater risk of cumulative impact. In the event that one or more spills occur during the gray whale migration period, and assuming that the spills occur offshore of the Olympic Peninsula, the Makah whale hunt could be affected. (Oil exposure to marine mammals, including the gray whale, was described in Section 4.8.4.3, with cumulative impacts noted as negligible to moderate.) Cumulative impacts are potentially more severe if tribal hunts were to be delayed or postponed due to oil presence or spill cleanup operations. Under these circumstances, whaling activity would be affected (i.e., delayed or postponed), and the Makah community would be disrupted.

However, a disproportionate high/adverse environmental justice affect is very unlikely. It is unlikely because of the low probability of an oil spill occurring in a specific location, at a specific time, and at an intense severity, all coinciding with the whale hunt.

Conclusion: Oil spills from any source would be the primary cause of impacts to sociocultural systems. The impact of a large tanker spill on sociocultural systems is expected to range from **negligible** to **moderate.** The contribution of the 2002 OCS Program to the cumulative impacts is expected to be **minor**. For subsistence resource users, disproportionate high/adverse environmental justice impacts are possible, but very unlikely.

4.8.4.12. Archaeological Resources

The following analysis considers the effects of trawling; sport diving; commercial treasure hunting; seasonal storms and El Niño events; channel dredging; and activities associated with the proposed action, prior, and future OCS sales in the Pacific Region. Specific types of impact-producing factors related to OCS mineral development considered in this analysis include drilling rig and platform emplacement, pipeline emplacement, anchoring, new onshore facilities, ferromagnetic debris associated with OCS activities, and oil spills.

Prehistoric Resources

Offshore development could result in an interaction between a drilling rig, platform, pipeline, or anchors and an inundated prehistoric site. This direct physical contact with a site could destroy artifacts or site features and could disturb the stratigraphic context of the site. The result would be the loss of archaeological data on prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts for the Americas.

The MMS currently requires that an archaeological survey be conducted prior to development of mineral leases determined to have potential for prehistoric archaeological sites. It is assumed that the archaeological survey has effectively mitigated most impacts from routine operations related to OCS mineral exploration activities. However, impacts to prehistoric resources may have resulted from OCS routine activities prior to the implementation of the archaeological survey requirement, but the magnitude of this possible impact is impossible to quantify.

Onshore development could result in direct physical contact between the construction of new onshore facilities or pipeline trenches and previously unidentified prehistoric sites. This direct physical contact with a prehistoric site could cause physical damage to, or complete destruction of, information on the prehistory of the region and North America. Federal and State laws and regulations initiated in the 1960's began requiring archaeological surveys prior to permitting any activity that might disturb a significant archaeological site. Therefore, it can be assumed that, since the introduction of the archaeological resource protection laws, most coastal archaeological sites have been located, evaluated, and mitigated prior to construction. However, impacts to coastal prehistoric resources may have resulted from onshore construction activities prior to enactment of the archaeological resource protection laws, but the magnitude of this possible impact is impossible to quantify.

Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high probability for prehistoric archaeological sites as they are associated with drowned river valleys, which are known to have a high probability for prehistoric sites. It is assumed that some of the archaeological data that have been lost as a result of dredging have been significant and unique; therefore, the impact to prehistoric archaeological sites as a result of past channel dredging activities has probably been moderate to major. In many areas, the COE now requires remote sensing surveys prior to dredging activities to minimize such impacts (Espey, Huston & Associates, 1990).

Trawling activity only affects the uppermost portion of the sediment column. This zone would already be disturbed by natural factors relating to the destructive effects of marine transgression and continuing effects of wave and current action. Therefore, the effect of trawling on most prehistoric archaeological sites would be minor.

Seasonal storm events impact broad areas of the coastline. The extreme storm events associated with El Niño conditions can significantly increase coastal erosion. Prehistoric sites in shallow waters or coastal sites are exposed to the destructive effects of wave action and scouring currents during these events. Under such conditions, it is highly likely that artifacts would be dispersed and the site context disturbed, resulting in the loss of archaeological information. Overall, a significant loss of data from nearshore and coastal prehistoric sites has probably occurred, and will continue to occur, from the effects of seasonal storms and El Niño events. It is assumed that some of the data lost have been significant and/or unique, resulting in a moderate to major level of impact.

The cumulative case scenario includes assumptions of the number, size, and probability of occurrence of oil spills from OCS activities and an estimate of the number of large spills from tankers (Table 4-6c). An oil spill could impact coastal prehistoric archaeological sites. Archaeological resource protection during an oil spill requires specific knowledge of the resource's location, condition, nature, and extent prior to impact; however, the Pacific coastline has not been systematically surveyed for archaeological sites. The MMS baseline studies have compiled information on over 4,440 known prehistoric archaeological sites along the Pacific coastline, and there are likely many more sites that have yet to be discovered. Thus, any spill that contacts the coast has a high potential to impact a prehistoric site.

Heavy oiling of a coastal area (Whitney, 1994) could conceal intertidal sites that may not be recognized until they are inadvertently damaged during cleanup. Crude oil may also contaminate organic material used in ^{14}C dating, and, although there are methods for cleaning contaminated ^{14}C samples, greater expense is incurred (Dekin et al., 1993). The major source of potential impact from oil spills is the harm that could result from unmonitored shoreline cleanup activities. Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with effective training and supervision. Damage or loss of significant archaeological information could result from the contact between an oil spill and a prehistoric archaeological site, but it is unlikely that entire sites would be destroyed without any mitigation during cleanup activities; therefore, the cumulative impact from oil spills to prehistoric archaeological sites would probably be moderate.

Historic Resources

Direct physical contact between a routine activity and a shipwreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb the site context. The result would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel's crew, and the concomitant loss of information on maritime culture for the time period from which the ship dates.

The MMS currently requires that an archaeological survey be conducted prior to development of mineral leases when a historic-period shipwreck is reported to lie within or adjacent to the lease area. It is assumed that the archaeological survey has effectively mitigated most impacts from routine operations related to OCS mineral exploration activities. However, impacts to historic-period shipwrecks may have resulted from OCS routine activities prior to the implementation of the archaeological survey requirement, but the magnitude of this possible impact is impossible to quantify.

Onshore development could result in direct physical contact between the construction of new onshore facilities or pipeline trenches and previously unidentified historic sites. Federal and State laws and regulations initiated in the 1960’s began requiring archaeological surveys prior to permitting any activity that might disturb a significant archaeological site. Therefore, it can be assumed that, since the introduction of the archaeological resource protection laws, most coastal archaeological sites have been located, evaluated, and mitigated prior to construction. However, impacts to coastal historic sites may have resulted from onshore construction activities prior to enactment of the archaeological resource protection laws, but the magnitude of this possible impact is impossible to quantify.

Trawling activity in the Pacific Region only affects the uppermost portion of the sediment column. On many wrecks, this zone would already be disturbed by natural factors and would contain only artifacts of low specific gravity (e.g., ceramics and glass) which have lost all original context. Therefore, the effect of trawling on most historic shipwreck sites would be minor.

Sport diving and commercial treasure hunting are significant factors in the loss of historic data from shipwreck sites. While commercial treasure hunters generally impact wrecks with intrinsic monetary value, sport divers may collect souvenirs from all types of wrecks. It is assumed that some of the data lost have been significant and/or unique. The known extent of these activities suggests that they have resulted in a major impact to historic-period shipwrecks.

Seasonal storm events impact broad areas of the coastline. The extreme storm events associated with El Niño conditions can significantly increase coastal erosion. Shipwrecks in shallow waters and coastal historic sites are exposed to the destructive effects of wave action and scouring currents during these events. Under such conditions, it is highly likely that artifacts of low specific gravity would be dispersed. Some of the original information contained in the site would be lost in this process, but a significant amount of information may also remain. Overall, a significant loss of data from historic sites has probably occurred, and will continue to occur in the Pacific Region from the effects of seasonal storms and El Niño events. It is assumed that some of the data lost has been significant and/or unique, resulting in a moderate to major level of impact.

Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high probability for historic shipwrecks, and the greatest concentrations of historic wrecks are likely associated with these features. Assuming that some of the data lost have been unique, the impact to historic sites as a result of past channel dredging activities has probably been moderate to major. In many areas, the COE now requires remote sensing surveys prior to dredging activities to minimize such impacts (Espey, Huston & Associates, 1990).

Past, present, and future oil and gas exploration and development on the OCS will result in the deposition of tons of ferromagnetic debris on the seafloor. This modern marine debris will 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 increases the potential that significant or unique historic information may be lost. However, the MMS requires avoidance or investigation of any unidentified magnetic anomaly prior to permitting bottom-disturbing activities; therefore, the increase in impacts to historic shipwrecks from magnetic masking is probably minor.

The cumulative case scenario includes assumptions of the number, size, and probability of occurrence of oil spills from OCS activities and an estimate of the number of large spills from tankers (Table 4-6c). An oil spill could impact a coastal historic site, but the direct impact of oil on most historic sites would be temporary and reversible. The major source of potential impact from oil spills is the harm that could result from unmonitored shoreline cleanup activities. Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with effective training and supervision. Damage or loss of significant historic information could result from oil-spill cleanup activities, but it is unlikely that entire sites would be destroyed without any mitigation during cleanup activities; therefore, the cumulative impact from oil spills to historic archaeological sites would probably be moderate.

Conclusion: Under the cumulative scenario, the impact to both prehistoric and historic archaeological sites from routine OCS activities should be **minor** due to archaeological surveys which are required prior to disturbance. However, routine activities that were approved prior to initiating the survey requirement may have impacted significant archaeological sites, but the magnitude of this possible impact is impossible to quantify. Of the non-OCS-related factors that impact archaeological sites, channel dredging and seasonal storms could possibly cause a **major** impact to both prehistoric and historic sites. Commercial treasure hunting and sport diving could also cause a **major** impact to historic-period shipwreck sites. The primary oil-spill impacts to both prehistoric and historic archaeological sites would result from cleanup activities, and it is estimated that this impact would be **moderate**. The incremental contribution of oil-spill impacts under the proposal to the cumulative impacts on archaeological resources in the Pacific Region should be very small.

4.9. Unavoidable Adverse Environmental Effects

4.9.1. Impacts on the Physical and Biological Environment

Some unavoidable adverse effects on water quality could occur as a result of the proposed action. Operational discharges of drilling muds and cuttings, formation water, and small amounts of hydrocarbons into the water column during routine offshore oil and gas operations would lower local water quality. These discharges could raise levels of some water quality parameters above normal within 100 m to 2000 m of the discharge point temporarily (up to 3 months) during drilling and intermittently/continuously during the production period.

An increase in emissions of air pollutants would occur. Emissions of NO_x and reactive hydrocarbons would increase ozone concentrations in the immediate vicinity of the offshore operations for intermittent periods during the term of the proposal. In areas where offshore oil and gas activities occur near onshore nonattainment areas, emission offsets may be required. Offshore emissions for the proposal should be less than 5 percent of the existing onshore emissions.

Marine mammals would be adversely affected by noise and disturbances associated with routine offshore activities (seismic surveys, vessels, aircraft, drilling, and dredging) during relatively brief periods of time. Some marine mammals would exhibit, short-term responses to noises and disturbance, such as confusion or avoidance. Bowhead whales, for example, will exhibit avoidance behavior to noise producing activities. Assuming an oil spill occurred and contacted marine mammals it is probable that some would experience minor short-term effects, while a small number would die. An oil spill would also adversely affect local marine mammal prey resources in small areas affected by a spill.

Adverse disturbances of terrestrial mammals by offshore-related aircraft, vehicles, facilities, human presence, and habitat alteration from construction activities are unavoidable. Disturbance of caribou, bears, and other animals in Alaska would be temporary and would not affect their overall distribution and abundance.

Marine and coastal birds would be adversely affected by noise and disturbances associated with routine offshore and onshore activities. Habitat alteration from the construction of onshore facilities would affect a small portion of the available habitat but would not cause long-term habitat loss. Assuming an oil spill occurred and contacted marine and coastal bird habitat, some birds would experience minor short-term effects, while some birds which feed in or rest on the water could be coated with oil and die. An oil spill could also adversely affect local marine and coastal bird prey resources.

Juvenile fish could be adversely affected by disturbances and turbidity associated with routine offshore and coastal activities. Wetland and estuarine habitat alteration resulting from pipeline and other related coastal construction would have an unavoidable adverse impact on fish nursery areas. Assuming an oil spill occurred and contacted fish habitat, there would be an adverse effect on local fishery stocks and food webs.

The most likely adverse effects to sea turtles would result from vessel trips and noise. Although individual turtles may be injured or killed from collisions, impacts to the population would be minor. The most likely impacts from noise would be short-term behavioral changes such as diving and evasive swimming. Most impacts on sea turtles resulting from solid debris would be avoided. If an oil spill were to occur and contact sea turtles, it is possible that some individuals might not recover from exposure, but sea turtle populations as a whole would not be threatened.

Some adverse effects on coastal wetlands caused by facility construction are likely to be unavoidable. Some small operational oil spills resulting from coastal construction are unavoidable. However, the effect of these spills should be localized (within 100 m of the construction site).

Adverse effects on seafloor habitats and associated organisms could occur from anchoring, drilling discharges, structure emplacement and removal, and pipeline emplacement. Assuming an oil spill occurred and contacted the seafloor, there would be an adverse effect on seafloor habitats and associated organisms within the area affected by the spill.

4.9.2. Impacts on the Socioeconomic Environment

Commercial and to a lesser extent recreational fisheries will be adversely effected by loss of fishing areas occupied by offshore vessels, platforms, and exposed pipelines. Oil spills and operational discharges could contaminate, injure, or kill shellfish, finfish, eggs and larvae in the vicinity.

Unavoidable adverse effects could occur to tourism and recreation areas from floating debris and oil spills that contact beach areas. Effects on scenic quality could also occur.

The proposed action with its ancillary activities will place increased demands on coastal communities. Potential oil spills could disrupt their economies. Some unavoidable adverse effects on subsistence harvests in the Alaska Region may result from routine offshore oil and gas activities. These offshore and onshore activities could cause localized displacement or loss of small numbers of subsistence resources. If oil spills were to occur and contact bowhead and beluga whales and walrus, there could be a reduction of total annual harvests of these species. Short-term loss of some subsistence resources and potential repercussions on the culturally significant sharing system would be unavoidable.

Unavoidable adverse effects to archaeological resources could occur as a result of the proposed action. Construction and siting of offshore and onshore oil and natural gas facilities such as platforms, pipelines, or processing facilities could displace, damage, or destroy archaeological resources.

4.10. Relationship Between Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

The **short-term uses** of man’s environment in relation to the OCS oil and gas program have to do with changes to the environment resulting from the offshore and onshore activities needed to develop oil and gas resources to meet the energy needs of the nation. The MMS makes every attempt to minimize those short-term effects. By adopting mitigating measures for OCS operations, MMS attempts to minimize long-term impacts and maintain or enhance the **long-term productivity** of areas in which oil and gas have been exploited. With proper removal of offshore oil and gas facilities, or their disposal in areas designed to enhance recreational fishing, offshore areas will continue to produce fish resources and provide habitat for marine mammals, birds, and reptiles long after oil and gas operations have ceased. The onshore effects of the OCS program and this proposed action will contribute to the continuing alteration of nearby coastal areas, from biologically productive natural environments to urbanized and industrialized environments.

Short-term use of the environment in the vicinity of OCS activities refers to the exploration and development of OCS oil and gas resources during the period of activity needed for the completion of the proposed action. The overall life of the proposed action is estimated to be about 25 to 40 years, with about 10 years of oil and gas exploration and delineation activity and about 25 years of resource development and production activity. Many of the effects discussed in Chapter 4 are the result of short-term uses and are greatest during the exploration, development, and early production phases. These effects may be reduced by mitigation measures described in Appendices D and E.

Extraction and consumption of offshore oil and natural gas would be a long-term depletion of nonrenewable resources. Economic, political, and social benefits would accrue from the availability of these natural resources. Most benefits would be short term and would decrease the Nation's dependency on oil imports. If additional supplies of oil and natural gas were discovered and developed, the emplaced production system would enhance its extraction. The production of offshore oil and natural gas from the proposed action would provide short-term energy and perhaps additional time for the development of long-term alternative energy sources or substitutes for these nonrenewable resources.

Onshore facility construction (e.g., pipelines, processing facilities, service bases, etc.) causes definite short- and the long-term changes, with localized long-term effects on coastal habitats along onshore pipeline corridors. Some biological resources, such as nesting birds, may have difficulty repopulating altered habitats and could be permanently displaced from the local construction area. Short-term biological productivity would be reduced or lost in the immediate onshore areas where construction takes place; however, the long-term productivity of some of these areas could be mitigated with habitat reclamation.

After the completion of oil and gas production, the marine environment is generally expected to remain at or return to its normal long-term productivity levels. To date, there has been no discernible decrease in long-term marine productivity in U.S. offshore areas where oil and gas have been produced for many years. In other areas that have experienced apparent increases in oil pollution, such as the North Sea, some long-term effects do appear to have taken place. Populations of pelagic birds have decreased markedly in the North Sea in recent years. However, this trend seems to have started prior to the beginning of North Sea oil production.

In the Alaska Region, habitat destruction could cause a local reduction in subsistence resources, which could threaten the regional economy and weaken the core values of sharing Native goods and subsistence as a way of life. Road construction resulting from the proposed action will improve somewhat accessibility to primitive areas in the region. The wilderness values of the coast and along pipeline routes and associated access roads would decrease with increased human activity in these areas. Land-use changes would be noticeable at onshore facility sites and along pipeline routes. Short-term changes include a shift in land use from subsistence-based activities to industrial activities during the life of the proposed action. Areas adjacent to onshore facilities and pipeline corridors would probably be subject to hunting regulations. Land use in some localized areas would change from conservation to resource development. This would be a short-term change if, after production ceases, land use reverts to previous uses. Long-term effects on land use may result if the infrastructure or facilities continue to be used after the lifetime of the proposed action. Potential users would be other resource developers, residents, or nonresidents who have become accustomed to the convenience of traveling the associated roads.

Increased population, minor gains in revenues, and the consequences of oil spills all contain the potential for disrupting coastal communities in the short term. In Alaska, added incentive to shift from a subsistence-based economy to a cash-based economy, a reduction in subsistence resources, a decrease in subsistence activities, and other changes brought about by the proposed action could be factors in long-term consequences for Native social and cultural systems.

Archaeological and historic finds discovered during development would enhance long-term knowledge. Overall, finds may help to locate other sites; but destruction of artifacts would represent long-term losses.

4.11. Irreversible and Irretrievable Commitments of Resources

4.11.1. Mineral Resources

Assuming the undiscovered, economically recoverable offshore oil and natural gas resources estimated to be leased in the proposed action were discovered, they would be irretrievable once they are consumed, although it is feasible to recycle some petroleum hydrocarbon products.

4.11.2. Biological Resources

Offshore and onshore oil and gas activities, such as aircraft, vessel, and vehicle traffic, facility construction, platform removal, could permanently displace some fauna and flora species from favorable habitats to unfavorable habitats. Displacement and habitat loss may result in the reduction of some local populations and become irretrievable if alterations to the environment were permanently maintained. However, the degree of displacement and amount of irretrievable habitat loss should represent a transitory and negligible effect on the overall populations of species.

An irreversible and irretrievable commitment of biological resources may occur where wetlands are impacted by dredging, construction activities, or oil spills. Dredging and construction activities can destroy wetland vegetation, which results in soil erosion and wetland loss.

4.11.3. Land Use and Socioeconomic Resources

It is unlikely that the landscape would revert to its predevelopment characteristics. However, land used for support of oil and gas development and processing may become favorable to other urban or industrial uses.

Many important aspects of North Slope Alaskan Inupiat society and culture are centered around subsistence hunting of the bowhead whale and the sharing of its meat. In the event that noise disturbance or oil spills disrupted the harvesting of bowhead whales, there could be a loss to Inupiat social and cultural values. Such a loss may be irreversible and irretrievable, potentially resulting in social stress in the communities and a breakdown of family ties and in the communities' sense of well-being. Taking into account existing onshore energy development and other ongoing processes of social change, the proposed action may contribute in the long term to the irretrievable loss of the Inupiat language and other cultural behaviors.

4.11.4. Archaeological Resources

Irretrievable prehistoric archaeological sites and cultural materials may be lost through looting and indiscriminate or accidental activity on known and unknown sites. Loss of ground context in which artifacts are located is a very important factor in dating and relating an artifact to other artifacts. The orientation programs and the archaeological protection requirements should mitigate some losses.

5. CONSULTATION AND COORDINATION

5. CONSULTATION AND COORDINATION

5.1. Process for the Preparation of the 5-Year Program

5.1.1. Draft Proposed Program

The process for the development of the draft proposed program and associated environmental impact statement (EIS) began with the mailing of letters soliciting comments from the Governors of affected States and the heads of interested Federal Agencies. A *Federal Register* (FR) Notice (65 FR 77665), published on December 12, 2000, requested comments from all affected parties on the development of the new program. Commenters were asked to provide information and comments relevant to determining the size, timing, and location of sales, and fair-market-value provisions to be considered in the draft proposed program. Based on the comments and information received, a draft proposed program was prepared and distributed for review.

5.1.2. Proposed Program

On July 23, 2001, an FR Notice (66 FR 38314) was published requesting comments from States, local governments, other interested individuals and groups, the oil and gas industry, and Federal Agencies to provide comments on the draft proposed program. Comments were solicited during a 60-day comment period ending on September 21, 2001. After consideration of the comments and any necessary revisions to the analysis in the program decision document, a proposed program was published on October 26, 2001, in the *Federal Register* (66 FR 208). The proposed program was submitted to Congress, the Governors of the affected States, and the U.S. Attorney General. The Governors and heads of Federal Agencies also received a written explanation from the U.S. Department of the Interior (USDOI) concerning the reasons for the decision.

5.1.3. Proposed Final Program

An FR Notice, published October 26, 2001, solicited comments on the proposed program. The 90-day comment period ended January 24, 2002.

Based on consideration of the comments and an updated analysis, a proposed final program was announced at the same time this final EIS was issued. This proposal was submitted to the President and to the Congress, along with an explanation from the USDOI concerning the reasons for the decision. After a 60-day waiting period, final approval can be given to the new program.

5.2. Process for the Preparation of the Draft EIS

Preparation and review of the EIS closely parallels that of the 5-year program decision documents. Comments received on the program decision documents are also reviewed for consideration in the preparation of the EIS.

Consultation and coordination was conducted with Federal, State, and local government agencies; members of the oil and gas industry; special-interest groups; and individual citizens. Coordination was carried out pursuant to the National Environmental Policy Act (NEPA) regulations which require a continuous and open process for determining the range of issues to be addressed and for identifying the significant issues related to the proposed action. This process not only identifies significant issues but also narrows the focus of the EIS.

5.2.1. Notice of Intent to Prepare an EIS

The Notice of Intent (NOI) to prepare an EIS for the proposed program was published in the *Federal Register* (65 FR 77665) on December 12, 2000, to initiate the scoping process. Comments were solicited early in the process to identify issues and alternatives which should be evaluated in the EIS. The NOI was combined with a Notice requesting comments on preparing the 5-year leasing program for 2002-2007. The USDOI, Minerals Mangement Service (MMS), received nearly 9,900 responses to the NOI. About 99 percent of these came as electronic mail, mostly from private citizens. However, most responses (98%) were submitted as form letters or slightly modified form letters containing essentially the same information. Thus, the preponderance of the responses were identical. The EIS issues raised in response to the NOI are summarized and evaluated in Section 1.2 (The Scope of the EIS).

5.2.2. Preliminary EIS Data Gathering

The collection and maintenance of a comprehensive inventory of resource data involve an ongoing process which encourages communication with all interested agencies and groups. It not only provides the resource data for the analysis in the EIS, but also identifies significant public concerns.

Information is also gathered through the MMS Environmental Studies Program (ESP). The ESP was initiated in 1973 to support the USDOI's oil and gas program. The objective of the ESP is to establish information needed for prediction, assessment, and management of impacts on the Outer Continental Shelf (OCS) and the nearshore areas that may be affected (43 U.S.C. 1346) by the proposed program. An overview of the ESP and information on ongoing MMS studies is available at the MMS web site (*http://www.mms.gov/eppd/sciences*). Results of more current studies are also presented in the proceedings of MMS Information Transfer Meetings conducted in the Gulf of Mexico, Pacific, and Alaska Regions.

Meetings were held which addressed consideration of significant issues and public concerns for inclusion in the 5-year program, and specifically in the 5-year EIS. Issues of concern in Alaska were considered at public/community meetings held in Alaska during January 2001 at Anchorage, Fairbanks, Barrow, Kaktovik, Point Hope, Kotzebue, Kivalina, Homer, Soldotna, and Kodiak. Comments on the 5-year program were also sought at the OCS Lease Sale 181 draft EIS public hearings held in New Orleans (Louisiana), Mobile (Alabama), and Pensacola and Tallahassee (Florida) in January 2001. Likewise, comments on the 5-year program were sought in conjunction with the January 2001 scoping meeting on a development plan EIS in Santa Maria, California.

Scoping for the 5-year EIS also included consideration of comments made in regard to previous and concurrent OCS lease sale EIS’s. For example, the applicability of some comments made on the OCS Lease Sale 181 draft EIS for the eastern Gulf of Mexico were considered for the 5-year EIS.

5.2.3. Comments on the Draft Proposed Program

As part of the scoping process initiated in December 2000, comments received in response to the FR Notice (66 FR 3814) from affected and interested parties on the draft proposed program were considered in the preparation of the EIS. The issues raised are summarized in Section 1.2.

5.3. Distribution of the Draft EIS

A Notice of Availability of the draft EIS was published in the *Federal Register* (66 FR 208) on October 26, 2001. Approximately 700 copies of the draft EIS were distributed to Federal, State and local agencies, and interested groups and individuals who provided comments at each stage of the preparation of the 5-year program and the EIS, and to coastal libraries.

Federal Agencies:

U.S. Environmental Protection Agency, U.S. Department of Commerce, U.S. Department of Defense, U.S. Department of Energy, U.S. Department of the Interior, U.S. Department of Transportation, Marine Mammal Commission, and U.S. Coast Guard.

Congress:

House of Representatives-Committee on Resources and United States Senate-Committee on Energy and Natural Resources.

State Agencies:

Copies of the draft EIS were provided to the governors and clearinghouses of the following States:

Alabama, Alaska, California, Connecticut, Delaware, Florida, Georgia, Louisiana, Maine, Maryland, Massachusetts, Mississippi, New Hampshire, New Jersey, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, South Carolina, Texas, Virginia, and Washington.

Coastal Libraries:

Copies of the Draft EIS were provided to various coastal libraries in the following States:

Alabama, Alaska, California, Connecticut, Delaware, Florida, Georgia, Louisiana, Maine, Maryland, Massachusetts, Mississippi, New Hampshire, New Jersey, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, South Carolina, Texas, Virginia, and Washington.

5.4. Comments Received on the Draft EIS

The 90-day comment period on the draft EIS closed on January 24, 2002. During this review period, written and oral comments were solicited on the adequacy of the draft EIS, and to provide the Secretary of the Interior with additional information to help evaluate the potential environmental effects of the 5-year program.

5.4.1. Public Hearings for the DEIS

Twelve public hearings were held from December 3, 2001 to January 10, 2002, at the following locations: Houston, Texas; New Orleans, Louisiana; Mobile, Alabama; and Anchorage, Soldotna, Homer, Kodiak, Barrow, Kotzebue and Nome in Alaska. A total of 37 people presented comments at the hearings. Listings of those who presented comments are presented below.

The public hearings in Alaska were conducted in hub communities adjacent to the Alaska planning areas which have proposed lease sales in the 5-year program. In addition, two public hearings via teleconference were held in Anchorage to receive comments from outlying communities.

New Orleans Public Hearing, December 10, 2001

Individual	Organization
Roy Francis	LA1 Coalition
Darryl Malek-Wiley	Sierra Club
Aaron Viles	U.S. Public Interest Research Group
Phil Smith	National Ocean Industries Group
Loulan Pitre	U.S. Congressman of Louisiana

Houston Public Hearing, December 10, 2001

Individual	Organization
Kim McGuire	City of Corpus Christi
Christopher Seaver	Hydril Company
Earl Sims	Sims Consulting

Mobile Public Hearing, December 12, 2001

Individual	Organization

No oral statements were made.

Anchorage Public Hearing, December 3, 2001

Individual	Organization
Melanie Duchin	Greenpeace
Martin Robards	Ocean Conservancy
Benjamin Entidings	Alaska Marine Conservation Council
Richard Sheard	private citizen
Kate Taylor	private citizen
Pamela A. Miller	private citizen
Sara Chapell	Sierra Club
Theresa Obermeyer	private citizen
Jenna App	Trustees for Alaska
Michelle Wilson	Alaska Center for the Environment
Mat Singer	private citizen
Louis Epstein	Cook Inlet Keeper

Soldotna Public Hearing, December 4, 2001

Individual	Organization

No oral statements were made.

Homer Public Hearing, December 5, 2001

Individual	Organization
Roberta Highland	Kachemak Bay Conservation Society
Nancy Hillstrand	private citizen

Kodiak Public Hearing, December 7, 2001

Individual	Organization
Mike Milligan	private citizen
Bob Scholze	Kodiak Island Borough

Barrow Public Hearing, December 7, 2001

Individual	Organization
George Ahmaogak, Sr.	Mayor, North Slope Borough
Edward Itta	Alaska Eskimo Whaling Commission
Foster Simmonds	private citizen
Ned Arey	Wildlife Commission
Craig George	Dept. of Wildlife Mgt., North Slope Borough
Robert Suydam	Dept. of Wildlife Mgt., North Slope Borough
Frank Willingham	Ilisagvak College
Johnnie Brower	private citizen
Fred Kanayosak	whaling captain
Anne Jensen	UIC Science Division

Kotzebue Public Hearing, December 4, 2001

Individual	Organization

No oral statements were made.

Nome Public Hearing, December 5, 2001

Individual	Organization
Robert Fagerstrom	private citizen
Irene Anderson	Sitnasuk Native Corporation
Leo Rasmussen	Mayor, Nome

Anchorage Public Hearing via Teleconference, January 8, 2002

Individual	Organization

No oral statements were made.

Anchorage Public Hearing via Teleconference, January 10, 2002	
Individual	**Organization**
No oral statements were made.	

5.4.2. Written Comments on the Draft EIS

The following is a list of 74 organizations and individuals who submitted written comments. We also received 4,528 copies of e-mail messages which are identical to or based on two different form messages posted on an environmental group's internet web site. The comments included in Appendix F are representative of all significant issues and concerns that were raised during the public review of the draft EIS.

FEDERAL GOVERNMENT

Agency	Name
Congress of the United States House of Representatives	Jeff Miller
U.S. Department of Commerce Office of the Undersecretary for Oceans and Atmosphere National Oceanic and Atmospheric Administration	Margaret R. McCalla
U.S. Environmental Protection Agency Office of Federal Activities	Anne Norton Miller
U.S. Department of Transportation U.S. Coast Guard	Jeffrey P. High

STATE GOVERNMENT

Agency	Name
Alabama	
Office of the Governor	Don Siegelman
Alabama Historical Commission	Elizabeth Ann Brown
Alaska	
Office of the Governor Office of Management and Budget Division of Governmental Coordination	Patrick Galvin
California	
Office of the Governor	Gray Davis
California Coastal Commission	Peter M. Douglas
Florida	
Department of Environmental Protection	Lisa Polak Edgar

STATE GOVERNMENT (Cont.)

Agency	Name
Hawaii	
Department of Health	Gary Gill
Louisiana	
Department of Natural Resources	Terry W. Howey
Texas	
Texas Natural Resource Conservation Commission	Jim Muse

LOCAL GOVERNMENT

Agency	Name
Alaska	
City of Nuiqsut City Mayor and Council Members	Eli Nakapigok
Lake and Peninsula Borough	Marvin R. Smith
Port Graham Village Council	Violet Yeaton
North slope Borough Office of the Mayor	George N. Ahmaogak, Sr.
Inupiat Community of the Arctic Slope	Edith Tegoseak
Florida	
Pinellas County Board of Commissioners	Barbara Shen Todd
Louisiana	
Greater LaFourche Port Commission	Ted M. Falgout

SPECIAL INTEREST GROUP

Organization	Name
Alaska Eskimo Whaling Commission	Maggie Ahmaogak
Alaska Marine Conservation Council	Benjamin Enticknap
American Petroleum Institute	Betty Anthony
American Petroleum Intitute, Upstream	V. Kenneth Leonard
Domestic Petroleum Council	William F. Whitsilt
Ecoslo	Pamela Marshall Hethearington
Environmental Defense	Richard Charter
Independent Petroleum Association of America	Charles D. Davidson
National Parks Conservation Association	Joan Frankevich

SPECIAL INTEREST GROUP (Cont.)	
Organization	**Name**
Ocean Conservancy (and Sierra Club, Greenpeace, Inc., Arctic Connections, Trustees for Alaska, Alaska Wilderness League, Natural Resources Defense Council, the Wilderness Society, Earthjustice Legal Defense Fund, Inc., National Environmental Trust, Northern Alaska Environmental Center, Alaska Community Action on Toxicity, and Alaska Center for the Environment)	Martin Robards

PRIVATE CITIZEN	
Individual	**State**
Ahmasuk, Austin	Alaska
Akpik, Joseph	Alaska
Ballentive, Wand	Ohio
Coomer, Kevin	Washington
Cummings, Terry	Alaska
Davidson, Nancy	Alaska
Denison, Mr. & Mrs.	California
Esch, Patricia	Virginia
Hoffman, Mary	Ohio
Hunter, Raleigh	North Carolina
Kostival, Benjamin	Maine
Kratzer, Kyann	Pennsylvania
Kuizenga, Marin	Alaska
Pici, Melissa	Virginia
Porter, Marian	Virginia
McCarron, John	New Jersey
McConnauhey, Evelyn	Oregon
Onteiro, Sergio	California
Nelson, Daniel	Ohio
Olson, Marc	Minnesota
Peters, Laura	Alaska
Peters, Susan	California
Rapone, Rebecca	Massachusetts
Rapoza, Arthur & Helen	Massachusetts
Sieward, George	California
Simpson, Gary	Colorado
Smith, Stanislav	Illinois
Thacker, Anita	Massachusetts
Voorhies, Bill & Marilyn	Maine
Zwell, Michael	Illinois
Hall, Don (and 4,516 identical letters)	Tennessee
Johnson, Bela (and 12 identical letters)	Maine

5.4.3. Responses to Comments

A total of approximately 110 organizations and private citizens commented on the draft EIS. An additional 4,528 private citizens commented using copies of e-mail messages which were identical to two form letters. All comments received were reviewed, and pertinent comments dealing with the analysis in the EIS were analyzed to determine whether changes were necessary in the EIS. Where minor (generally technical) changes were required, they were made in the text without acknowledgement.

We received numerous comments that did not suggest changes to the EIS, as such, but offered a point of view or suggested a course of action for the OCS oil and gas program. While 2 commenters supported three sales rather than two in the eastern Gulf of Mexico, about 30 commenters supported the no-action alternative. Most of these commenters went on to suggest that national energy policy should shift away from fossil fuels and should emphasize conservation and alternative energy sources. The primary reasons given for this proposed change in policy were the security risk posed by offshore structures and the fact that the OCS can only be a minor contributor to worldwide oil reserves. These comments are a part of the public record that is available to decisionmakers in the course of developing national energy policy.

A variety of suggestions were received to exclude certain areas from the program that did not correspond directly to the proposed exclusions in alternative 3. We received over 4,500 essentially identical letters and several additional letters from individuals opposed to offshore drilling anywhere on the Alaska OCS. A few commenters suggested excluding the Beaufort Sea Planning Area, while one or two individuals proposed excluding either the Cook Inlet, Norton Basin, Hope Basin, or the Eastern Gulf of Mexico Planning Area. A number of commenters recommended expanding the area under consideration in the Eastern Gulf of Mexico to at least the original size of the proposed OCS Lease Sale 181 area. These comments were taken into account when MMS developed the proposed final program.

The form letters noted above also expressed concern about the effects of seismic survey noise on sperm whales in the eastern Gulf of Mexico and the limited effectiveness of oil-spill cleanup technology, especially in sea-ice conditions. These issues are discussed in the EIS in Section 4.3.2.3. and Appendix C, respectively. These commenters also opposed the use of floating, production, storage, and offloading systems (FPSO's) in the Eastern Gulf of Mexico. We issued an EIS in January 2001 on the use of FPSO's in the Gulf of Mexico.

We will take into account in subsequent planning and analysis the recommendations from a few individuals for amending our planning process and making better use of local input, advisory groups, and research organizations.

The following is a summary of the major issues and specific concerns raised by the commenters and the responses to these issues and concerns including, where appropriate, an indication of resulting changes made in the final EIS.

ISSUE 1: The EIS preparation and review process was faulty.

Issue Was Raised By: North Slope Borough (NSB), Mayor George N. Ahmaogak, Sr.; Environmental Defense; Anchorage, Alaska, public hearing testimony.

Concern: The NSB expressed concern that comments they had submitted during scoping were either ignored or not meaningfully addressed in the draft EIS.

Response: We considered the comments submitted by the NSB when developing the alternatives and issues to be analyzed in the EIS. Section 1.2. describes the scoping process and explains the reasons for including or not including various alternatives and issues in this document. Some of the recommendations from the public are beyond the scope of the programmatic EIS but will be addressed in subsequent NEPA analyses.

Concern: Environmental Defense claimed the draft EIS comment period needs to be extended because the E-mail address announced by MMS for submitting comments is inoperative.

Response: We regret that we were unable to accept comments by E-mail because access to MMS and USDOI via the Internet has not been available due to a court order. We included the regular mailing address for submitting written comments in our October 26, 2001, announcements of the availability of the draft EIS. We recognize that many individuals may not have completed their reviews until the last day of the comment period, only to find after preparing their message that they could not respond by email. Therefore, we accepted any comments mailed shortly after the comment period closed on January 24, 2002. The 90-day comment period is twice that required by NEPA regulation and is adequate for parties to complete a thorough review of the draft EIS. Therefore, the comment period was not extended.

Concern: A testifier at the Anchorage, Alaska, public hearing stated that it was premature for MMS to announce that three sales would be held in the Beaufort Sea before the 5-year program EIS was completed.

Response: We have not made a decision to hold three sales in the Beaufort Sea or in any of the planning areas identified in the proposed program. However, for those proposed sales scheduled early in the 2002-2007 Program, we need to begin the lengthy planning and analysis process prior to program approval. This will ensure that we complete a comprehensive analysis, as required by law prior to making a decision on any sale.

ISSUE 2: Analysis does not meet NEPA requirements.

Issue Was Raised By: State of California, Governor Gray Davis; California Coastal Commission (CCC); North Slope Borough (NSB), Mayor George N. Ahmaogak, Sr.; The Ocean Conservancy, et al.; Alaska Eskimo Whaling Commission (AEWC); Anchorage, Alaska, public hearing testimony.

Concern: The State of California asked for more detailed analyses in the final EIS of the impacts on cetaceans from additional underwater noise and the increased potential for vessel strikes from OCS tankers on the west coast. The CCC argued that the draft EIS failed to adequately analyze the impacts of tankers carrying OCS oil from Alaska on California's coastal resources.

Response: No OCS areas in the Pacific Region are being considered for leasing in the proposed program. Therefore, we limited the scope of the environmental description and analysis on the west coast to only the potential impacts from tankers carrying oil from the Alaska OCS to west coast ports. At this stage in the program, it is highly uncertain how much oil will be tankered along the west coast, what routes those tankers would take, or what ports they would enter. In light of this uncertainty, we had no basis for developing more explicit scenarios of potential OCS tanker activity along the west coast. Therefore, we did not include in the EIS detailed descriptions of the west coast environment or detailed analyses of impacts to west coast resources. Future leasing in the Beaufort Sea or elsewhere on the Alaska OCS may result in the transportation of oil by tanker from the port of Valdez to west coast ports. The NEPA process for those lease sales, as well as for subsequent development and production proposals, will evaluate further the potential impacts of transporting the oil by pipeline and tanker, as appropriate.

Concern: The NSB recommended that the definitions of impact levels for biological resources in the cumulative case analysis take into account effects occurring over multiple seasons or years and also multiple actions occurring over a single season or year. The Ocean Conservancy, et al., argued that the impact levels as defined for this EIS (Section 4.2.) do not take into account the effects on habitats and vastly underestimate impacts.

Response: The impact levels in the EIS use the ability of the biological resource to recover as the primary criterion for impact severity, which takes into account effects over more than one season or year, effects of multiple actions, and effects on habitats. The impact levels apply to the analysis of the proposal and alternatives as well as to the cumulative analysis. We believe the conclusion for each resource is supported by the analysis and, therefore, does not underestimate the impacts. This is a programmatic EIS with potential impacts over broad and very diverse geographic areas. An affected resource may be an entire community or population, or the geographic extent of the resource may be very limited. For these reasons, we developed impact levels that can be applied consistently throughout the document and provide the reader and decisionmaker with a clear basis for weighing the environmental implications of the proposal.

Concern: The AEWC stated that the draft EIS does not meet NEPA standards, disregards important research, lacks analytical content, is inconsistent, and that in its cumulative analysis, it neglects the impacts of past, present, and reasonably foreseeable non-OCS oil and gas future activities.

Response: We believe the EIS fully meets NEPA requirements. In their letter, the AEWC went on to identify specific aspects of the EIS that they consider to be inadequate. We address these comments under appropriate issues in this section, including Issue 9 (cumulative impacts), Issue 14 (mitigation measures), Issue 15 (environmental justice), Issue 20 (marine mammals), Issue 28 (economic impacts), and Issue 32 (sociocultural systems). Although the amount of research on the Alaska offshore and coastal environment is extensive, the EIS analysis is based on much of the current scientific research relevant to the analysis of offshore oil and gas activities. The sources are identified in the references section (Appendix F) of Volume II of the final EIS. Regarding the criticism of the analysis generally, we believe the analytical method is sound, considering the degree of uncertainty at the OCS program stage. Namely, we establish a baseline environment (Chapter 3) and then use hypothetical scenarios of possible oil and gas activity to estimate the impacts to that environment. We express conclusions using four impact levels to provide the reader with a clear summary statement about the possible severity of impacts to specific resources and communities. Regarding the criticism of the cumulative analysis, Section 4.8.1 describes a range of non-OCS oil and gas activities that could contribute to cumulative impacts in Alaska. The subsequent cumulative analyses for the Alaska Region (Section 4.8.3) use the relevant activities in the cumulative scenario to assess the impacts on specific resources or issues on a case-by-case basis.

Concern: One testifier at the Anchorage, Alaska, public hearing recommended a more in-depth analysis of impacts in Alaska because of the harsh environment.

Response: We have taken a closer look at all the analyses in the draft EIS in light of comments received from the public, and we have revised sections as appropriate. In general, we believe the analyses take into account the unique environmental conditions in Alaska as described in Chapter 3 of the EIS. More in-depth analyses are performed for proposed lease sales in each planning area and for subsequent exploration and development proposals.

ISSUE 3: Restricting the planning areas included in the proposal and alternatives was improper.

Issue Was Raised By: U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA); North Slope Borough (NSB), Mayor George N. Ahmaogak, Sr.

Concern: NOAA claimed that our decision to limit the suite of OCS planning areas available for leasing consideration in this 5-year program is itself a Federal action subject to NEPA and that we need to assess and compare the impacts of leasing among all OCS planning areas. Without considering all 26 planning areas in the proposal, NOAA argued, we fail to offer a reasonable set of alternatives. NOAA recommended that the EIS specify if planning areas have been excluded due to Administrative policy, and they go on to claim that "NEPA identification and consideration of alternatives should not be preempted or constricted by the existence of state or Federal laws which would otherwise prohibit OCS leasing."

Response: There is no requirement to include all OCS planning areas in the proposed 5-year program that we subject to NEPA analysis. In fact, eight whole planning areas located off the east and west coasts and off Alaska, and most of the Eastern Gulf of Mexico Planning Area located off Florida, which have been subject to annual congressional moratoria for over a decade, were withdrawn by the President from leasing consideration until after June 30, 2012. NOAA's claim that we should subject to NEPA analysis OCS areas where leasing is legally prohibited is unreasonable. In addition to the planning areas removed by the President, other areas located off Alaska also were excluded from the proposed program primarily because they have low oil and gas resource value and are of little or no interest to the oil and gas industry at this time. The alternatives analyzed in the EIS are reasonable considering the factors that determined the scope of the proposed action. The Purpose and Need for the Proposed Action (Section 1.1) explains the reasons for limiting the areas under consideration for leasing that are subject to NEPA analysis.

Concern: The NSB questioned whether all planning areas on the east and west coasts should be excluded from the program while the Beaufort Sea and Chukchi Sea Planning Areas, which are highly sensitive, unique, and vulnerable to impacts, are included in the proposal.

Response: We agree that the arctic is a sensitive, unique environment, and that is taken into account in the development and analysis of the proposal and alternatives. At some point in the planning for previous 5-year leasing programs, most areas of the OCS have been identified by various parties as unique and sensitive, and the basis for those assertions has been carefully considered in developing the 5-year lease schedule. While environmental factors are an important consideration in developing the program proposal, it should be noted that other factors are considered, in particular, oil and gas resource potential, industry interest, and the views of the Governors of coastal States. After weighing all factors, we excluded sizable areas on the Alaska OCS from the proposed 2002-2007 program. No sales are scheduled in 10 of the 15 Alaska OCS Planning Areas, and only limited portions of the five remaining planning areas, including the Chukchi and Beaufort Seas, are being considered for leasing. Furthermore, having sales in the 5-year program is not a guarantee that those sales will be held. Subsequent decisions are made for each scheduled sale concerning sale area configuration, mitigation measures, and whether to hold the sale at all. Two of the three sales scheduled in the arctic in the current 5-year program were cancelled.

ISSUE 4: The EIS scope and/or assumptions are improper.

Issue Was Raised By: State of California, Governor Gray Davis; Alaska Eskimo Whaling Commission (AEWC); Ocean Conservancy et al.; Environmental Defense; Susan M. Petersen; New Orleans, Louisiana, public hearing testimony; Anchorage and Kodiak, Alaska, public hearing testimony.

Concern: The State of California expressed a concern about the impacts of OCS leasing off California and information gaps in addressing these impacts.

Response: No future leasing off California is proposed by the 5-year program. Impacts of tankering Alaska oil to California ports are presented in Section 4.3.4 for the proposed program and in Section 4.8.4 for the cumulative scenario.

Concern: The AEWC pointed out that the EIS should note that the British Petroleum's Northstar Project has now commenced oil production.

Response: The final EIS text has been revised, e.g., in Section 4.8.1.1, and now indicates that oil production at the Northstar Project started in November 2001.

Concern: The Ocean Conservancy et al., asked that zero discharge in water be evaluated in the EIS, and that information on localized drilling-mud-related pollution surrounding the Gulf of Mexico platforms be addressed.

Response: As indicated in Section 1.2.5.2 of the final EIS, zero discharge of drilling wastes and produced water is more appropriately considered during specific leasing proposals and during review of the subsequent development and production plans. The feasibility and need for zero discharge varies considerably among planning areas. As regards localized drilling-mud release surrounding Gulf of Mexico platforms, this is addressed in the EIS in Section 4.3.2, for example under Section 4.3.2.1. Water Quality and Section 4.3.2.9.5. Other Benthic Communities.

Concern: The Ocean Conservancy et al., stated that the draft EIS lacked sufficient detailed information regarding infrastructure associated with the proposed development and, in turn, the specific impact assessment associated with this. They mentioned lack of information in the EIS on such items as gravel causeways, docks, gravel islands, land clearing, floodplain sand and gravel removal, pipeline landfalls, onshore bases, roads, etc. Also, they stated that inadequate data were presented on the importance of productivity at the entrance of Cook Inlet.

Response: The specificity of information and impact analysis requested by the commenter is not commensurate with the programmatic analysis in this EIS. Such specific information and concerns are more appropriately addressed during analysis of specific lease-sale proposals and during review of subsequent development and production plans. The information available on the proposed action at the program stage is broad and general in scope.

Concern: The Ocean Conservancy et al., stated that Figures 3-31 and 3-32 in the EIS should also depict wilderness areas.

Response: We disagree that this is needed. Please see the response to Issue 27 for an explanation of why we do not describe and depict all protected areas, such as wilderness areas, in this EIS.

Concern: The Ocean Conservancy et al., stated that the EIS did not consider reasonable alternatives which would limit geographical scope of the planning areas and lease sales in Alaska.

Response: Section 1.2.4.1 explains our reasons for delaying such limitations until subsequent analysis of specific sale proposals. Also, see Issue 15 responses for more information.

Concern: Environmental Defense stated that the EIS failed to fully comply "with the federal Endangered Species Act (ESA), including the provision of Section 7 consultations relative to all potentially impacted species subject to ESA listing."

Response: Section 1.2.2.4 of the final EIS explains why the ESA Section 7 consultations are not needed until the specific lease-sale stage analysis.

Concern: Environmental Defense stated that floating storage and processing vessels were not being considered in the program scenario.

Response: In the transportation assumptions for the Gulf of Mexico Region, the final EIS mentions production in deep water and transportation to shore by shuttle tanker. This includes the floating production, storage and offloading (FPSO) system scenario. At this time, we do not know which development and production system will be proposed for projects. In December 2001, we issued a programmatic EIS for the use of FPSO's in the Gulf of Mexico. Additional analysis will be conducted if specific proposals are submitted for the use of FPSO's.

Concern: Environmental Defense suggested that the proposed drilling of delineation wells on active leases offshore California is a focus of a separate and concurrent EIS process by MMS and should be fully evaluated in this 5-year program EIS as part of the cumulative impact.

Response: We disagree with this suggestion. Our reasons are explained in Section 1.2.2.3 of the final EIS.

Concern: Ms. Susan M. Petersen stated that the EIS was making assertions of oil-spill impacts "in the absence of any information on the amount of oil that will be produced as a result of the various leasing alternatives and the resulting spill risk."

Reponse: A discussion of the method used to develop the oil and gas resource estimates used for the analyses in this EIS is provided in Section 4.3.1 of the final EIS. Estimates of anticipated oil and gas production for the proposal and each alternative are presented in Tables 4-1a and b, 4-2a and b, etc. As regards oil-spill risk, please see response to Issue 12.

Concern: A testifier at the New Orleans, Louisiana, public hearing stated that the expansion of Port Fourchon and associated impacts were not addressed in the EIS.

Response: The Port Fourchon concern mentioned by the testifier is discussed in Section 4.3.2.12 in the final EIS. A more detailed impact analysis would be provided in the subsequent sale-specific EIS.

Concern: Another testifier at the New Orleans, Louisiana, public hearing said that the EIS did not adequately address significant environmental problems that accompany oil and gas activity. Mention was made specifically in regard to OCS pipelines crossing coastal wetlands in support of OCS production from the Gulf of Mexico.

Response: This programmatic EIS does address significant environmental problems in all areas being considered for leasing. In Section 4.3.2.8.2, while pipeline effects are not specifically called out, the effects of routine activities and oil spills on wetlands are addressed.

Concern: A testifier at the Anchorage, Alaska, public hearing stated that the EIS ignores the risk and impact of OCS offshore oil and gas exploration in the Beaufort, Chukchi, and Bering Sea regions on the arctic coastal communities.

Response: We believe the EIS addresses the impacts of the proposed program on arctic coastal communities. The analysis is based on reasonable assumptions concerning activities that could occur if the proposed sale schedule is adopted, and provides sufficient information to support the program decision. For example Sections 4.3.3.14 (Sociocultural Systems) and 4.3.3.15 (Environmental Justice), clearly address these concerns. However, these concerns will be treated in much greater detail in subsequent EIS's for specific lease sales in these regions.

Concern: A testifier at the Anchorage, Alaska, public hearing stated that the final EIS should spend a "fair amount of time in addressing the impacts associated with day-to-day operations and not just that dealing with offshore blowouts and catastrophic spills."

Response: In fact, that is exactly how the EIS addresses impacts. The impacts addressed in Section 4.3 (Environmental Impacts of Alternative I – Proposed Action) and elsewhere are considered under the categories of "Routine Operations" and "Accidents" (oil spills).

Concern: Another testifier at the Anchorage, Alaska, public hearing said that the EIS needs to "consider the multiple effects of transforming the entire region of lower Cook Inlet from a sustainable economy based on fishing, tourism, and other services to an industrial economy based on nonrenewable resources."

Response: Neither the proposal, alternatives, nor the cumulative case scenarios would result in such an industrial economy. Estimated impacts are indicated in Sections 4.3.3.10 (Population, Employment, and Regional Income) and 4.3.3.11 (Land Use and Existing Infrastructure).

ISSUE 5: The EIS does not include all relevant available information.

Issue Was Raised By: U.S. Environmental Protection Agency (USEPA); U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA); State of Florida, Department of Environmental Protection (DEP); State of Alaska, Governor Tony Knowles; State of California, Governor Gray Davis; Tri-Boroughs of Alaska (Kenai Peninsula Borough, Kodiak Island Borough, and Lake and Peninsula Borough); North Slope Borough (NSB), Mayor George N. Ahmaogak, Sr.; City of Nuiqsut, Alaska; The Ocean Conservancy, et al.; Environmental Center of San Luis Obispo, California; Environmental Defense; numerous individuals; Anchorage and Kodiak, Alaska, public hearing testimony.

Concern: The USEPA recommended that we include in the EIS the results of previous 5-year leasing programs, namely, a comparison of how many sales were scheduled and how many were actually held. They also recommended we provide greater detail on the underlying assumptions used to develop the proposed action.

Response: We included a description of the leasing history on the OCS in the draft proposed program that was issued in July 2001 (USDOI, MMS, 2001a). We do not include a leasing history in the EIS because it does not have a bearing on the analysis. The Purpose and Need discussion in the EIS begins with a summary of the factors we considered in developing the proposed action (Section 1.1). These factors were discussed further in the proposed program document (USDOI, MMS, 2001b) and are repeated in the final program. Weighing these factors constitutes the underlying assumptions for the proposal. In summary, the proposed leasing program balances the resource values and industry interests in particular OCS areas with the potential for environmental damage and competing uses, while also considering the recommendations of affected State and local governments.

Concern: The USEPA recommended that we include in the EIS a comparison of the predicted and actual impacts of past 5-year leasing programs.

Response: Impacts can be somewhat overstated in our programmatic EIS's because scenarios used for the analysis are conservative in describing the types and levels of activity that could occur, fewer sales are ultimately held than planned, and additional block deletions and mitigation are often adopted at the lease-sale stage which further reduces impacts. There is a high degree of uncertainty at the programmatic stage regarding which sales will be held and what level of exploration and development activity will ultimately occur. However, the EIS must describe for decisionmakers the potential impacts that could occur, even unlikely impacts, should the proposed sales be conducted. A comparison of predicted and actual impacts of past leasing programs is generally conveyed in two sections of the EIS. First, the description of the affected environment (Chapter 3) constitutes a baseline for the EIS analysis, and as such, impacts from past oil and gas activities, as well as non-OCS activities, are reflected in the descriptions of affected resources. Second, the cumulative analysis (Section 4.8) considers past leasing programs and, to the extent possible, describes the degree to which impacts from the proposed program contribute to the overall impacts.

Concern: NOAA stated that the draft EIS did not discuss the potential impacts of invasive species and recommended that OCS activities comply with programs to minimize the introduction of invasive species. The State of California asked that the final EIS discuss west coast ballast water exchange initiatives and whether Alaska OCS tankers will observe these invasive species control measures.

Response: A discussion of invasive species can be found in Section 4.1.3. of the EIS. As noted in that discussion, we are cognizant of our obligations to comply with the Invasive Species Executive Order issued by the President in February 1999. Many west coast ports and harbor districts have established ballast water control programs to prevent the introduction of exotic species into local waters. We assume Alaska OCS tankers will comply with the mandatory requirements of these programs as well as with the applicable mandatory requirements of the U.S. Coast Guard's Ballast Water Management Program. The U.S. Coast Guard regulates tanker vessel traffic, and MMS does not know to what extent tankers carrying Alaska OCS crude oil will comply with the voluntary requirements of Federal, State, or local ballast water management programs.

Concern: The Florida DEP said it would be helpful if the geographic coordinates for the program area in the eastern Gulf of Mexico were provided.

Response: Although we do not include the geographic coordinates of the proposed program areas in the EIS, that information is available upon request. The MMS Gulf of Mexico OCS Regional Office can provide a list of the blocks proposed for leasing consideration in the Eastern Gulf of Mexico Planning Area. The geographic coordinates could also be provided on a case-by-case basis.

Concern: The Tri-Boroughs of Alaska stated in their Tri-Borough Position Paper that our EIS's should address five critical issues for lower Cook Inlet and Shelikof Strait: (1) the various means of transporting oil in these dangerous navigable waters, (2) plans to minimize or avoid conflicts with commercial fishing activities, (3) the adequacy of oil-spill prevention and response capabilities, (4) the identification of critical habitat areas in lease sale EIS's, and (5) provisions for providing impact assistance revenues from the OCS leasing program to the boroughs. The State of Alaska asked that we consider the Tri-Borough Position Paper in the EIS.

Response: (1) The EIS scenarios assume any oil produced in Cook Inlet from the proposed program would be transported to shore by subsea pipeline (Section 4.3.1.4). This will be consistent with the Tri-Boroughs' recommendation that oil not be offloaded from the platforms onto tankers. The EIS to be prepared for the proposed lease sales in Cook Inlet and the NEPA analyses for subsequent development proposals will describe and analyze in more detail the transportation of the oil. (2) The EIS describes potential conflicts with fishing activities (Section 4.3.3.12) and notes that, in the past, cooperative agreements have been set up between the oil industry and fishermen to minimize conflicts. Such programs would be continued as new OCS activity is proposed in Cook Inlet. The EIS also identifies types of stipulations that are developed and adopted at the lease-sale stage, including a measure to avoid conflicts with fishing activities (Appendix D). The EIS to be prepared for the proposed Cook Inlet lease sales will describe and analyze a sale-specific stipulation. (3) Appendix C of the EIS describes oil-spill response capabilities for offshore oil and gas operations generally. Appendix D identifies Information to Lessees that are issued in the Alaska Region. For example, oil-spill contingency plans must be prepared by lessees and approved by MMS prior to approval of exploration and development plans. Furthermore, the State of Alaska will review these oil-spill plans as part of the Coastal Zone Management Act consistency review process. (4) The lease sale EIS for Cook Inlet will describe and analyze the critical habitat of important fish species in Cook Inlet and Shelikof Strait. (5) Regarding impact assistance, see Issue 28.

Concern: The City of Nuiqsut cautioned that our analyses need to consider the force of moving ice in the Beaufort and Chukchi Seas and the damage the ice can do to manmade structures on the OCS.

Response: We agree with the City of Nuiqsut that ice poses a unique hazard to OCS structures in the arctic region (see Section 4.1.4.2). Federal regulations require that lessees design, build, install, and maintain OCS structures to ensure their structural integrity for the specific environmental conditions where the structures will be located (30 CFR 250.900). The OCS pipelines subject to MMS approval also must be designed and installed to take into account environmental factors, including the potential for ice damage (30 CFR 250.1002).

Concern: The NSB stated that all mitigation measures developed for recent Beaufort Sea lease sales, including the stipulation with a 10-mile Cross Island exclusion zone, should be assumed to be in place for purposes of the programmatic EIS and should be included in Appendix D.

Response: We assume for purposes of analysis in this EIS that certain mitigation measures adopted for previous Beaufort Sea sales are likely to be adopted for future sales with little or no substantive change. Other mitigation, such as the stipulation with an exclusion zone around Cross Island, is expected to be modified for future Beaufort Sea lease sales (see Issue 16). Such a stipulation will be analyzed in the next Beaufort Sea lease sale EIS. Other mitigation measures are likely to be developed, or previous measures updated based on new information and consultations. Because the protection afforded by these new or updated measures could be substantively different from previous measures, they are not assumed to be in place for purposes of the analyses in this EIS.

Concern: The NSB suggested that the analysis for the proposed program should take into account the recommendations of the National Research Council (NRC) following completion of their ongoing study of the cumulative effects of North Slope oil and gas activities. The NSB also recommended that the EIS reflect MMS's commitment to the recommendations of the OCS Policy Committee 1993 report, *From Conflict to Consensus*.

Response: The NRC study will not be completed in time to be included in this EIS. Once the study is completed, the results will be included in future NEPA analyses for OCS oil and gas proposals in the arctic. The Secretary of the Interior considers the recommendations of the OCS Policy Committee, including the 1993 report, *From Conflict to Consensus*, when making decisions concerning the OCS oil and gas program.

Concern: The State of California asked that additional information be included in the final EIS concerning tankering of OCS oil from Alaska to west coast ports. In particular the State requested that the EIS state how many additional tanker trips there would be annually to west coast ports, whether improvements or expansions of existing California facilities will be needed, and what portion of the Alaska oil will be handled by member companies of the Western States Petroleum Association. The Environmental Center of San Luis Obispo asked that additional information be included in Affected Environment, Pacific Region (Section 3.3), including various designated estuaries and parks along the coast; coastal flora; offshore banks; canyons; and areas of upwelling, benthic communities, and archaeological sites.

Response: We estimate between 26 and 54 tanker trips annually would transport Alaska OCS oil to west coast ports if the anticipated production for the Alaska OCS in the proposed program is realized. It is expected that North Slope crude oil shipments from Valdez to west coast ports will continue to decline, and estimated oil production from the Alaska OCS would only replace a portion of the decline. Therefore, expansion of California ports or oil facilities will not be needed. We assume that vessels belonging to the Western States Petroleum Association will handle all the Alaska OCS oil shipped from Valdez. However, OCS oil would be mixed with North Slope oil in the Trans-Alaska Pipeline System, and MMS does not control or regulate tanker transportation.

No OCS areas in the Pacific Region are being considered for leasing in the proposed program. The scope of the environmental analysis on the west coast is limited to the potential impacts from tankers carrying oil from the Alaska OCS to west coast ports. At this stage in the program, we had no basis for developing explicit scenarios of potential OCS tanker activity along the west coast. Therefore, we did not include in the EIS detailed descriptions of the west coast environment. Future leasing in the Beaufort Sea or elsewhere on the Alaska OCS may result in the transportation of oil by tanker from the port of Valdez to west coast ports. The NEPA process for those lease sales, as well as for subsequent development and production proposals, will evaluate further the potential impacts of transporting the oil by pipeline and tanker, as appropriate.

Concern: The Ocean Conservancy et al., claimed that the draft EIS was deficient because it did not consider the extensive research done on the Exxon Valdez oil spill.

Response: We did use results from the Exxon Valdez oil spill research in the EIS analysis; over 35 reports from that research were listed in the references for the draft EIS. Some additional Exxon Valdez spill sources have been used for the final EIS, and they will be listed in the references which are included in the printed version of the final EIS.

Concern: The Ocean Conservancy et al., requested that more detail be provided in the maps depicting wildlife concentrations, migration routes, and other sensitive areas. They also asked that the platforms, wells, pipelines, and other infrastructure listed in the scenario tables be shown on maps.

Response: The environmental resource maps included in the EIS are intended as an aid to orient the reader and to complement the description of the environment in Chapter 3. The level of detail in the maps generally reflects the scope and specificity of the description in the text, which we believe is appropriate for a programmatic EIS. More detail is provided in subsequent lease sale and project-specific EIS's that cover much smaller geographic areas. Regarding the scenario information, at the time a 5-year program EIS is prepared, we do not know the location of proposed platforms, wells, and pipelines. We base the analysis on assumptions about where activity will occur generally, but we cannot identify specific offshore sites at this early stage. In fact, even at the lease-sale stage, the actual location of possible oil and gas activity is hypothetical. We do not know the actual proposed location of facilities until we receive exploration or development and production plans from lessees. The NEPA analyses for those plans is based on the proposed location of the structures.

Concern: Environmental Defense argued that environmental studies identified by the NRC need to be completed and the results included in the EIS for this leasing program.

Response: Research in the marine environment is an ongoing process that continuously provides agencies, organizations, and the public with additional information for conducting analyses, reviewing proposals, and making decisions. We make every effort to use the best information available at the time a particular NEPA analysis is conducted for a given proposal. We have done that for this program EIS. We continually update our information base with results of studies from numerous sources including our own extensive environmental studies program. While some unavailable information would be useful to our current analysis, it is not essential for this EIS or to support decisions on the proposed program. The final EIS includes the references used for preparing the document. Additional information recommended by commenters on the draft EIS has been incorporated, as appropriate. Responses to other issues in this section indicate how suggestions for using additional information were handled. Results of studies recommended by the NRC will be considered in the planning and analysis process for future OCS proposals as those studies are completed.

Concern: Several individuals stated that the draft EIS fails to mention that the United States has only three percent of global oil reserves, and, therefore, we need to rely more on alternative energy sources than on OCS oil and gas.

Response: No single source can meet all the energy needs of the country. The Nation's overall energy strategy encompasses a range of sources, including OCS oil and gas. Over time, development of alternative sources will provide a larger percentage of our energy needs relative to nonrenewable sources, but OCS oil and gas will continue to be a key element of our energy strategy for the near term. Section 4.7 of the EIS describes the likely mix of alternative sources of energy that would result if the proposed 2002-2007 leasing program is not adopted.

Concern: Ms. Susan Peterson stated that MMS should specify the life spans of pipelines proposed for OCS activities and assess the risk of using existing onshore aging infrastructure in Prudhoe Bay and Cook Inlet.

Response: We agree that the life span of all oil and gas facilities, including pipelines, is an important consideration for project planning, approval, and operations. All structures and equipment included in proposals submitted to MMS for OCS exploration and development must be designed to ensure safe operations for the life of the proposed project. We conduct a rigorous inspection program to ensure the integrity of offshore facilities. When specific plans are submitted to MMS for exploration or development activity in the Arctic or Cook Inlet, they will describe all phases of the proposed operation, including transportation of oil or gas to shore. The applicant and MMS assess the risk of the proposed activities as part of the review and decision process for each plan.

Concern: One testifier at the Anchorage, Alaska, public hearing objected that the references were not included in the printed draft EIS and had to be requested.

Response: We did not include the voluminous references with the printed EIS for reasons of efficiency. However, the references were included in the CD-ROM version of the Draft EIS, and printed copies of the references were readily available upon request. The references (Appendix F) are included in Volume II of the final EIS.

Concern: A testifier at the Anchorage, Alaska, public hearing asked that the final EIS include an analysis of the impacts of blowouts and tables showing revenues for fishing and tourism in Alaska as was provided for the Gulf of Mexico.

Response: The scenario we developed for the EIS analysis (Section 4.3.1) includes assumptions about potential oil spills, including spills from blowouts. We based these assumptions on a detailed record of spills that have occurred historically from all sources on the OCS, such as pipelines, tankers, and blowouts at rigs or platforms. Because this is a programmatic EIS, we analyze the potential impacts of particular size oil spills that could occur anywhere in the proposed program areas or along transportation routes. Subsequent NEPA analyses for particular lease sales or particular exploration or development proposals will provide more site-specific analyses of possible impacts from blowouts and other accidental events. The tables for Gulf of Mexico fishing and tourism (Tables 3-17 and 3-18) include employment data but do not include revenue data. We include data in tables for each Region if the data are available and are relevant to the analyses.

Concern: One testifier at the Barrow, Alaska, public hearing noted that the North Slope has already been adversely affected by pipelines and other oil and gas infrastructure.

Response: Communities and environmental resources on the North Slope that have been affected by onshore oil and gas activity are assessed in the cumulative analysis of this EIS if they could also be affected by oil and gas activities assumed to occur from the proposed leasing program. The cumulative analysis (Section 4.8) describes the potential impacts of past, present, and reasonably foreseeable future activities to those communities and environmental resources.

Concern: Two testifiers at the Barrow, Alaska, public hearing argued that MMS collects information from Native people at meetings but does not use the information.

Response: We have held numerous meetings throughout Alaska over the years as part of our ongoing efforts to keep the public informed and involved in planning for OCS oil and gas activities. We value the information we receive from residents at these meetings. We use the information, including traditional knowledge, to scope the issues to be analyzed in subsequent EIS's. However, we do not acknowledge every meeting in each EIS. Rather we use the most recent information to update and refine what we've presented in previous analyses. The focus and scope of the information will be different for the programmatic EIS than for lease sale or project-specific EIS's. The later analyses provide greater detail for a more limited geographic area than the analyses in the program EIS.

ISSUE 6. Not enough information exists to do an adequate analysis.

Issue Was Raised By: Environmental Defense; Anchorage and Barrow, Alaska, public hearing testimony.

Concern: The Environmental Defense and a testifier at the Anchorage, Alaska, public hearing expressed concern that MMS failed to consider the lack of adequate scientific information and understanding about effects of leasing in arctic waters needed to support the proposed lease sales in Alaska.

Response: The amount and detail of information needed for a NEPA analysis depends upon the decision it is intended to support. The analysis in this EIS must support a program-level planning decision for considering future OCS leasing proposals. The NEPA analyses for leasing, exploration, and production will be prepared at the time these actions are ripe for decision. This "tiered" approach to NEPA compliance and decisionmaking is encouraged by the NEPA regulations (see 40 CFR 1502.20 and 1508.28). The NEPA analyses prepared for past OCS program proposals have been reviewed by the courts. In no case did a court find that NEPA was violated because not enough information existed to prepare an adequate analysis.

Concern: The Environmental Defense stated that the draft EIS must disclose the anticipated impacts derived from the proposed action on existing uses of the sea and seabed.

Response: We agree that the EIS must present the potential effects of the proposed program on existing uses of the sea and seabed. The environmental consequences of this proposal and alternatives can be found in Chapter 4 of the EIS. Some of the existing uses analyzed include: Department of Defense uses (Section 4.1.1); commercial fishing (Sections 4.3.2.13.1, Gulf of Mexico Region; 4.3.3.12, Alaska Region; and 4.3.4.9, Pacific Region); subsistence activities (Section 4.3.3.14, Alaska Region); and tourism and recreation (Sections 4.3.2.14, Gulf of Mexico Region; 4.3.3.13, Alaska Region; 4.3.4.10, Pacific Region). Some of the seabed resources analyzed include: seafloor habitats (see sections 4.3.2.9, Gulf of Mexico Region; 4.3.3.8 Alaska Region); submerged seagrass beds (Section 4.3.2.9.3, Gulf of Mexico Region), and chemosynthetic communities (Section 4.3.2.9.4, Gulf of Mexico Region).

Concern: A testifier at the Barrow, Alaska, public hearing submitted reprints of publications covering particular species (i.e., lesser snow geese and brant; king and common eiders; killer whales; harbor porpoises) that he felt were not adequately addressed in the draft EIS.

Response: The publications were distributed to the EIS authors, and information was used in the final EIS.

ISSUE 7. Analysis is not specific enough.

Issue Was Raised by: Environmental Defense.

Concern: The Environmental Defense criticized the draft EIS for failing to provide detailed information about the probable implications of OCS oil and gas development on the arctic waters and along the Alaska coastline and for failing to identify mitigation.

Response: The detail level of the analysis presented in the EIS is tailored to the decision it supports—the adoption of a nationwide schedule for leasing on the OCS over a 5-year period. It is appropriate that the analysis in the EIS is broad in scope because decisions on the proposed program will be broad in scope. A more specific analysis evaluating impacts from OCS lease development is not needed at this time because the decisions that will be made on the proposed 5-year program are not decisions to allow drilling or to develop OCS leases. The MMS will prepare NEPA analyses supporting OCS lease development decisions at the time those activities are being considered for approval, and those analyses will be more site-specific than the analysis in this EIS. As noted in the response to Issue 7, this "tiered" approach to NEPA analysis is provided for in the NEPA regulations. This program EIS does assess the likelihood and potential impacts from OCS development in the Alaska OCS Region (see Section 4.3.3 of the EIS). Most mitigation measures are developed during the planning and analysis stage for specific lease sales and, in some cases, for specific development proposals. At that time, the measures can be designed for the particular geographic area. In the analysis for the program EIS, we assume that mitigation measures that have been routinely adopted for past sales will be adopted for the sales in the proposed 2002–2007 program. The mitigation measures that have commonly been adopted in the past are described in Appendix D of this EIS. Some of these measures may be updated at the lease-sale stage based on new information.

ISSUE 8: Analysis and conclusions are not valid.

Issue Was Raised By: State of Florida, Department of Environmental Protection (DEP); North Slope Borough (NSB), Mayor George N. Ahmaogak, Sr.

Concern: The Florida DEP questioned the definition of minor impacts (Section 4.2.1), arguing that mitigation does not "avoid" impacts but attempts to minimize impacts.

Response: We define mitigation in our EIS's consistent with the definition in the regulations implementing the NEPA. Those regulations define the term broadly, stating in part, "Mitigation" includes: (a) Avoiding the impact altogether by not taking a certain action or parts of an action" (15 CFR 1508.20).

Concern: The NSB maintained that some Native knowledge of the residents of the North Slope is included in the draft EIS, but it is not reflected in the EIS conclusions.

Response: The conclusions in the EIS provide the reader with a summary statement of the level of impact estimated to occur if the proposed program is adopted. We do not distinguish in each conclusion between the various sources of information and analysis that form the basis of the conclusion. The analysis takes into account all available information, including the traditional and contemporary knowledge gathered from meetings and other sources. If Native knowledge supports a level of impact measurably different than the analysis using western science, that would be noted in the analysis. The "bottom line" conclusion for each topic reflects the analysis and judgment of the author considering all information for that topic.

ISSUE 9: The cumulative impact analysis is incomplete or inadequate.

Issue Was Raised By: The North Slope Borough (NSB), Mayor George Ahmaogak, Sr.; Alaska Eskimo Whaling Commission (AEWC); Ocean Conservancy et al.: Environmental Defense, Charter; New Orleans, Louisiana, public hearing testimony; Anchorage, Alaska, public hearing testimony.

Concern: The AEWC stated that the draft EIS lacked a "well-developed cumulative effects analysis" and consideration of "proper mitigation measures," especially as regards sociocultural impacts. NSB Mayor George Ahmaogak Sr. further stated that the EIS needs to more comprehensively treat the stress and anxiety that will continue to be felt by the North Slope Native community as a result of ongoing and future OCS activities. The Mayor felt that the related topics of deflection of whales (migration) out of reach of subsistence hunters and incorporation of effective mitigation for this was only "mentioned in passing in the DEIS" and did not support the conclusions reached in the draft EIS.

Response: We believe the scope of the cumulative analysis is appropriate for this programmatic EIS and is in accordance with the provisions of NEPA regulations to keep EIS's concise and no longer than absolutely necessary (40 CFR 1502.2(c)), to evaluate broad actions generically (40 CFR 1502.4(c)(2)), and to use tiering to focus on the actual issues ripe for decision (40 CFR 1502.20). If and when specific lease sales and specific projects are proposed, the treatment of cumulative impacts and mitigating measures will be further defined and addressed in detail. The topics of Alaskan Native anxiety and stress, effects on whale migration, and specific mitigation, are addressed in the final EIS (Sections 4.8.3.3.1 and 4.8.3.14) and will be comprehensively and more specifically analyzed in subsequent NEPA documents.

Concern: The AEWC also stated that the cumulative case treatment for Alaska (Section 4.8.3) "fails to provide any reasoned analysis of the incremental impacts of the proposed action in light of other federal and state actions in the waters of the Arctic." The Environmental Defense expressed a similar concern as regards the analyses for all planning areas.

Response: The cumulative case scenario (Section 4.8) does, in fact, include assumptions regarding activities other than OCS oil and gas development, such as State oil and gas development, dredging and marine disposal, and coastal community development. Tables 4-6b and 4-6c provide numerical estimates of the cumulative case exploration and development scenarios and oil-spill assumptions for the Alaska Region. Using this information, the impact analyses provide an overall cumulative assessment, and the conclusions clearly identify the estimated incremental contribution of the proposed action to the cumulative impacts. For example, the cumulative analysis for sociocultural systems (Section 4.8.3.14) clearly distinguishes the overall impacts and the contribution of the proposed action.

Concern: The Ocean Conservancy et al., stated that impacts of past, present, and future offshore exploration and development analysis for Alaska were inadequate. They said that the draft EIS underestimates the potential for significant impacts from "pollution, noise, disturbance, oil spills, greenhouse gas emissions, and support structures on coastlines."

Response: We disagree. The specific concerns mentioned are all considered in the EIS. The levels of impact were estimated using the impact level definitions provided in Section 4.2, and the analyses supporting these impact conclusions are presented for each resource affected.

Concern: The Ocean Conservancy et al., also stated that displacement of cetaceans due to seismic testing was not addressed in the cumulative analysis. They further stated that chronic impacts of "routine" oil and gas activities were not adequately considered and that these can cause the ecosystem to "die a death of a thousand cuts."

Response: Cetacean displacement due to seismic testing is considered in the cumulative case impact analysis in Section 4.8.3.3.1. Impacts from routine oil and gas activities are part of the cumulative impact analysis for each resource that may be affected (Section 4.8). However, these impacts are not specifically categorized under "routine operations" and "accidents" in the cumulative analysis as they are for the proposed action and alternatives. Impacts from routine operations will be analyzed in greater detail for lease sales and development projects when these are specifically defined. The cumulative case scenario consists of proposed, ongoing, and reasonably foreseeable future activities, including possible oil and gas activities for 40 years in the Beaufort Sea, and the analysis conforms with the regulatory definition that, "cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7).

Concern: The Environmental Defense stated that the "cumulative impacts associated with barging and tankering of produced OCS oil must be quantified and evaluated and adequate mitigation measures provided and their success rate assessed."

Response: The cumulative case analysis considers oil transportation by tanker, barge, and pipeline in the development scenario (Section 4.8.1) and oil spill assumptions (Table 4-6c). Further specifics of oil tankering or barging, including specific mitigation and success rate (effectiveness), are beyond the scope of this programmatic EIS. The NEPA process for specific lease sales, as well as development and production proposals, will subsequently further evaluate such potential impacts and mitigating measures.

Concern: A testifier at the New Orleans, Louisiana, public hearing said that the EIS should include information on the impact on highway LA1, a primary road corridor in coastal Louisiana, as a result of increased traffic from Port Fourchon associated with OCS deepwater development.

Response: Section 4.3.2.12 has been revised to indicate that impacts to Port Fourchon could be major. Further treatment (analysis and consideration of mitigation) of this concern will be included in the NEPA analysis associated with specific lease sales and project development.

Concern: Another testifier at the Anchorage, Alaska, public hearing stated that the EIS does not consider impacts to "other interests and the economy that's affected by other things other than pulling oil out of our oceans."

Response: Presumably, the commenter was referring to impacts on other economic resources such as commercial fishing, recreation, etc. In fact, the impacts on these resources are analyzed in Sections 4.3 to 4.7 for the proposed action and alternatives, and in Section 4.8 for the cumulative case.

ISSUE 10: Oil and gas resource estimates and supporting information need clarification.

Issue Was Raised By: The Ocean Conservancy et al.; Anchorage, Alaska, public hearing testimony.

Concern: The Ocean Conservancy et al., stated that the draft EIS makes assertions about oil-spill impacts without providing any clearly stated information on the amount of oil that will be produced as a result of the program.

Response: The EIS analysis is based on scenarios describing approximate levels of exploration, development, and production activities that could result from the program (see Section 4.3.1). The scenario data, which include approximate numbers of platforms, wells, pipelines, vessel trips, and other elements relevant to the analysis, are based on levels of anticipated oil and gas production. The scenarios are described in section 4.3.1., and the anticipated production and assumed levels of activity are provided in the scenario tables for the proposal and the alternatives in Volume II.

Concern: A testifier at the Anchorage, Alaska, public hearing stated that the EIS should indicate how much oil is available in known fields on the OCS and how much is expected to be found for each proposed lease sale.

Response: The oil and gas resource estimates for each program area in the proposed program are provided in Tables 4-1a (Gulf of Mexico) and 4-1b (Alaska). As noted in the text (Section 4.3.1.3), the amounts of oil and natural gas assumed to be discovered, developed, and produced are based on the condition that economically recoverable amounts of hydrocarbons are present in the planning areas. The analysis in this program EIS is based on scenarios for all proposed lease sales in each planning area. Resource estimates and analyses for individual lease sales will be provided in subsequent EIS's for individual sales or groups of sales in a planning area. We do not specify separately in the EIS the oil and gas resources available in known fields. However, the resource estimates used for the cumulative case scenarios and analyses are provided in Tables 4-6a (Gulf of Mexico) and 4-6b (Alaska). As noted in the text (Section 4.8.1.1), cumulative production estimates for each region include production from existing leases, estimated leases from the proposed program, and estimated leases in some OCS areas from subsequent OCS programs.

ISSUE 11: The oil-spill estimates, modeling, or impact analyses are deficient.

Issue Was Raised By: State of California, Governor Gray Davis; The Ocean Conservancy et al.; Alaska Eskimo Whaling Commission (AEWC); Anchorage and Barrow, Alaska, public hearing testimony.

Concern: The State of California recommended that the final EIS include a worst-case spill analysis for west coast tankers, oil-spill trajectory modeling for the port of San Francisco and the Santa Barbara Channel, additional information on recent spill events off California, and site-specific spill scenarios for California. The Ocean Conservancy et al., also recommended including a worst-case oil-spill analysis. The AEWC claimed that the draft EIS contained no oil-spill risk analysis and made no attempt to analyze potential impacts from oil spills.

Response: We do not conduct a worst-case spill analysis for our EIS's. In April 1986, the Council on Environmental Quality rescinded the requirement to prepare a "worst-case analysis." We believe an analysis based on a supportable scenario of exploration and development activity is a more effective approach to evaluate reasonably foreseeable significant impacts. We do not use our oil-spill trajectory model for 5-year program EIS's because at this stage the location and amount of exploration and development activity and, therefore, specific information about potential oil spills, are highly uncertain. To develop explicit spill assumptions and derive estimates of spill contact locations at the 5-year program stage would be misleading and give the false impression that we have information at this time to predict the fate of specific spill events. We apply our oil-spill risk model for our lease sale EIS's, and more site-specific analysis is also conducted on a case-by-case basis for some development proposals. The oil-spill analysis in the program EIS describes the potential impacts to affected resources assuming oil spills of varying sizes occur from platforms, pipelines, or tankers (see Section 4.3.1.5. and Tables 4-1c,d, and e).

Concern: The Ocean Conservancy et al., claimed that the oil-spill analysis for the no action alternative is flawed because it does not consider the cumulative risks of spills from existing OCS leases, exploratory drilling, and the Northstar project.

Response: The no action alternative is structurally different than the other alternatives in the EIS because it is not a variation of the proposal in terms of size, timing, or location of lease sales. Therefore, the analysis of the no action alternative was handled differently. Section 4.7 describes the most likely alternative energy mix that would replace the oil and gas resources estimated to be produced if the proposal were adopted. One element of this energy mix would be a significant increase in U.S. imports of crude oil. The EIS explains how this new energy mix would change the number and source of large spills estimated for alternative 1, and generally describes which resources would see a change in the severity of oil-spill impacts. The cumulative analysis (Section 4.8) describes the potential impacts of existing OCS leases, exploratory drilling, and reasonably foreseeable future projects.

Concern: Several testifiers at the Anchorage, Alaska, public hearing stated that the analysis of oil spills in Alaska does not support the conclusions. Testifiers stated that, in light of the effects of the Exxon Valdez oil spill, impacts from the proposed program would be more severe than we predicted. A testifier in Barrow stated that our EIS's underestimate the probability of a large spill occurring.

Response: We agree that a spill similar to the Exxon Valdez accident in Prince William Sound could have serious, long-lasting impacts. However, it is highly unlikely that a spill of that magnitude would occur as a result of the proposed leasing program. The oil-spill assumptions used for the EIS analysis are based on the oil resources estimated to be produced if the program is adopted and on the number and size of spills that have occurred historically on the OCS. Table 4-1e provides the oil-spill probabilities and assumptions for the proposed action used for the EIS analysis. Based on the oil resource estimates for the proposal, we estimate that the probability of one or more spills of at least 500 barrels occurring in the Beaufort Sea is between 81-94 percent and as high as 98 percent in the Chukchi Sea. The EIS analysis is based on the assumption that two large spills occur in the Beaufort Sea and three such spills occur in the Chukchi Sea (Table 4-1e). We have reconsidered our oil-spill analysis and believe that the conclusions in the final EIS concerning the potential impacts if oil spills occur are valid and supported by the analysis.

ISSUE 12: The analysis of the oil-spill cleanup capability was incomplete or inadequate.

Issue Was Raised By: The State of California, Governor Gray Davis; The State of Florida, Department of Environmental Protection (DEP); The North Slope Borough (NSB), Mayor George N. Ahmaogak, Sr.; The Ocean Conservancy, et al.; the Alaska Eskimo Whaling Commission; Environmental Defense, Charter; Alaska Marine Conservation Council; Sierra Club; several individuals; Alaska public hearing testimony.

Concern: Numerous commenters emphasized the very limited capability of current technology to effectively respond to and clean up oil spills in seasonal ice conditions and in the harsh arctic environment generally. The poor results of recent oil-spill drills in the arctic were noted.

Commenters questioned the decision to include areas on the Alaska OCS in the 5-year program in light of the limited oil-spill cleanup capability in the arctic.

Response: Decisions about the size, timing, and location of leasing in the 5-year program take many factors into account, including the risk of oil-spill occurrence, the potential environmental impacts should spills occur, and the capability to clean up oil spills in all areas being considered for leasing. In Appendix C, Oil Spill Response Capabilities for Offshore Oil and Gas Operations, we repeatedly stressed the minimal cleanup potential for mechanical recovery technology, even in ideal weather conditions. We cited in Appendix C (Section C.7.e.) the U.S. Coast Guard's (USCG) 1999 "Response Plan Equipment Caps Review: Are Changes to Current Mechanical Recovery, Dispersant, and *In Situ* Burn Equipment Requirements Practicable?" (Caps Review), which found that mechanical recovery generally results in recovering no more than 20 to 30 percent of spilled oil. In the Appendix (Section C.8.a.) we went so far as to find:

> ". . . in situ burning should be considered as a primary method of responding to oil spills during fall freeze-up ice conditions in the arctic, not a secondary or backup measure. Use of only mechanical containment and cleanup measures for primary response during fall freeze-up conditions could worsen the adverse effects resulting from a significant spill in arctic conditions. There is a relatively short window of opportunity for implementing successful in situ burning operations after a spill. This means that in situ burn operations should be preplanned and preapproved to ensure an adequate and timely response to a spill event."

Appendix C included information covering 20 years of evidence that in situ burning is a superior response technique for minimizing environmental damage from an oil spill. This, of course, is dependent on conditions being such that in situ burn operations can be conducted at a safe distance from biological and other resources that could be directly affected by burning oil.

Concern: The Ocean Conservancy et al., stated that MMS needs to include an analysis of the prospective longevity of an oil spill cleanup in summer to establish if oil will still be on the water at freeze-up.

Response: Above, we noted the 1999 USCG Caps Review finding that mechanical recovery generally results in recovering no more than 20 to 30 percent of spilled oil. This corresponds very well to other studies of mechanical response methods for oil spills over the years. Therefore, there is a strong likelihood that a major portion of any oil spilled in summer would remain on the water at freeze-up if only mechanical recovery methods were used following an arctic spill. If in situ burn operations are preplanned and preapproved, it would ensure a more effective and timely response to a spill event in all arctic conditions. As we noted in Appendix C, there is a relatively short window of opportunity for implementing a successful in situ burning operation after a spill.

Concern: The NSB stated: "MMS seems overly enthusiastic about the effectiveness of in situ burning as a spill response measure given the difficulties of initiating the process under frequently occurring arctic conditions, including broken and shifting ice, high, winds, high sea states, extreme cold, poor visibility, and prolonged darkness."

Response: We maintain that particularly for the arctic conditions described by the NSB, in situ burning is superior to all other response measures. The 1999 USCG Caps Review, cited in Appendix C, recognized it as "the only effective countermeasure for broken ice conditions." Concerning "the difficulties of initiating the process," Section C.7.f. of Appendix C cites the 1999 USCG Caps review finding that ignition systems for in situ burning have improved. This is particularly true for the Helitorch system, which is slung from a helicopter.

Concern: The Ocean Conservancy et al., contended that Appendix C on oil-spill cleanup capabilities presented misleading information on the "containment" of oil by sea ice because it ignores the Beaufort Gyre and the tremendous movement of pack ice. They also cited the example of a wrecked and ice-bound vessel, the *Karluk*, which drifted hundreds of miles through pack ice during the winter of 1913-1914.

Response: The studies and examples we cited in the Appendix C were concerned with landfast ice, not pack ice.

We are well aware of the fact that the ice en masse can shift in position dramatically given the weather conditions. During this shift, the ice would tend to check the oil's lateral spread and concentrate it in thicker slicks, which can be more easily cleaned up. The MMS requires that industry maintain an inventory of oil tracking buoys and run trajectory modeling to help anticipate the ice and oil's movements and improve the response team's ability to locate and remove oil in the environment.

Broken ice tends to concentrate oil in the area between the pieces. Again, numerous tests have shown that broken ice contains and concentrates oil so that in situ burning can be employed most effectively. The broken ice acts in the same way as a containment boom to ensure that the oil is thick enough to maintain burning. Ideally, in situ burning should be quickly employed long before oil could be widely distributed among pack ice floes.

Concern: The Ocean Conservancy et al., states that MMS "still holds up small, unsuccessful spill exercises from 1983 as demonstrations of industry in-situ burn capability."

Response: We included a discussion of the 1983 in situ burn tests in the Appendix C not as a sole justification of the in situ burning technology, but to show that successful in situ burning tests have been conducted for nearly 20 years. The initial tests may not have been entirely successful in all aspects, but first-time demonstrations of technology seldom are. The reference to the 1983 tests that The Ocean Conservancy et al., describes appears in Section C.8.a. of Appendix C. However, The Ocean Conservancy et al., overlooked the previous discussion of in situ burning technology in Section C.7.f. of the Appendix. There we discussed the positive findings on in situ burning of the 1999 USCG Caps Review, the successful in situ burn experiments during the 1989 *Exxon Valdez* spill, and the successful 1993 Newfoundland Offshore Burn Experiment jointly funded by MMS, USCG, the Canadian Coast Guard, and Environment Canada.

Concern: The Ocean Conservancy et al., stated with regard to mechanical oil-spill cleanup technology, that while MMS "describes the ineffectiveness of oil spill cleanup response measures in the Beaufort Sea, it failed to reference key documents relating to recent tests and evaluations (Robertson, T.L., and Elise DeCola, *Joint Agency Evaluation of the Spring and Fall 2000 North Slope Broken Ice Exercises*, December 18, 2000; Alaska Department of Environmental Conservation (ADEC) and Minerals Management Service, *Joint Evaluation*, January 18, 2000; and ADEC, *North Slope Drills and Exercises Response Tactics for BP Exploration's Northstar, Prudhoe Bay Western Operating Area and Endicott Operations* and ARCO's *Prudhoe Bay Unit and Greater Point McIntyre Area, Fall 1999.*) The NSB and several individuals expressed similar concerns regarding the 2000 response trials.

Response: In preparing Appendix C. Oil-Spill Response Capabilities for Offshore Oil and Gas Operations, MMS relied on its own summary analyses of the trials for mechanical cleanup operations under the Northstar oil-spill response plan (OSRP). The summary analysis in the draft EIS did consider the following reports, which we are incorporating into the Bibliography at the end of Appendix C of the final EIS:

> Alaska Department of Environmental Conservation and Minerals Management Service. 2000. Joint evaluation, fall 1999, North Slope drills and exercises response tactics for BP Exploration's Northstar, Prudhoe Bay Western Operating Area and Endicott Operations and ARCO's Prudhoe Bay Unit and Greater Point McIntyre Area. January 18, 2000.
>
> Robertson, T.L., and Elise DeCola. 20000. Joint agency evaluation of the spring and fall 2000 North Slope broken ice exercises. December 18, 2000.

For most of the year, the Alaskan Beaufort Sea is characterized by solid ice conditions. During these extended periods of time, industry would employ land-based spill response equipment and tactics to respond to a release. The oil companies on the North Slope maintain an extensive inventory of heavy equipment capable of collecting and removing large volumes of oiled snow and ice from the frozen ocean surface. They also maintain equipment that is capable of excavating oil imbedded in and under the ice surface.

The trials in 1999 and 2000 established realistic operating limitations for the barge-based response tactic. These operability limits are lower than initially thought, but the system would have recovered oil had it been present. The tactic as devised is labor intensive and requires constant monitoring but did work as described, but at a lower level of efficiency. This was one tactic available to the oil industry in responding to a release. Since those trials, industry has re-evaluated and modified their response tactics to utilize smaller more maneuverable systems that can better use the ice's natural containment attributes to recover oil. These tactics are routinely used in the Cook Inlet, another ice infested environment, to respond to spills during their long broken-ice season.

In responding to an oil spill, there a numerous tactics and options available. In ice infested waters, in situ burning of oil is one of the first response tactics that should be used. In situ burning has the potential to remove upwards of 90 percent of the oil from the ocean surface and limit effects on wildlife.

Concern: The Ocean Conservancy et al., took exception to the following explanation in Appendix C (Section C.6.c):

> "Because of the remoteness, relatively short drilling season, and other logistical considerations, the MMS Alaska OCS Region does not require unannounced oil-spill response drills for exploration drilling. Unannounced drills may be conducted in the future if production or other long-duration operations exist in the Region."

The Ocean Conservancy et al., stated that this explanation is outdated because production has begun on the Northstar offshore field. They that "it would seem logical that MMS could find a way to schedule some unannounced visits."

Response: We generally have not required unannounced drills in harsh operating environments because of natural hazards and the strong likelihood that offshore employees could be injured and equipment damaged during a hastily-called drill. We may reassess this policy now that the Northstar development project is actually producing.

Concern: Mr. Richard Charter of Environmental Defense insisted that "The 5-Year OCS Program and the accompanying EIS must quantify the minimum and maximum percentages of anticipated oil recovery for spills in various sea states, meteorological conditions, and sea ice conditions." The NSB expressed a similar concern.

Response: Section 7 of Appendix C, Oil-Spill Response Capabilities for Offshore Oil and Gas Operations, provides numerous descriptions of the effectiveness of various types of oil-spill response equipment. This includes a description of the estimated ranges of effectiveness for various types of equipment in Section C.7.b. Effectiveness of equipment further depends upon sea state, amount of oil, type of oil, degree of oil weathering, and how the equipment is used—e.g., with the wind and current, against the wind and current etc. The effectiveness of various equipment types and further research needs are fully described in Appendix C so that decisionmakers can make reasonable judgments about how well various equipment types work under various conditions. In Appendix C, we have freely and fully described the serious limitations of different equipment types, whether operating under ideal or severe conditions. A careful reading of Appendix C will support this. To provide the degree of detail implied by Mr. Charter and the North Slope Borough would be prohibitively expensive without adding a commensurate understanding of oil-spill response capabilities. Research monies would be better spent on development and testing new equipment and techniques.

For example, in 1995 MMS entered into agreements with various foreign governments, companies, and response organizations to develop the Program for Mechanical Oil Recovery in Ice-Infested Waters (MORICE). Various concept evaluations and prototypes of MORICE recovery systems have been conducted since 1997. In January 2002, the final developmental system was tested at MMS' Ohmsett test facility using ice-covered waters and various concentrations of oil. The MORICE system—using ice handlers, conveyor belts, water jets, sorbents, and pumps—successfully cleaned oil off individual blocks of ice and the water surface. Although not fully developed for operation at sea, the MORICE system has provided the first successful demonstration of a mechanical system to clean up oil in ice-infested waters.

Concern: The NSB expressed the view that "dispersants have been shown to be largely ineffective or their deployment has been determined to be problematic under arctic conditions." The NSB further noted that "There is no mention (in the EIS) of the identified ineffectiveness of dispersant delivery systems under arctic conditions."

Response: We addressed dispersants in Section C.7.g. of Appendix C. Although we did not specifically describe use of dispersants in arctic regions, we described many of the characteristics of dispersants that would lead one to conclude that they are less than ideal for use in, for example, the Beaufort Sea. The Beaufort Sea is shallow near the shore, is not a particularly high-energy or dynamic environment, and contains many biological and subsistence resources living near the shore. As outlined in Appendix C, dispersants are not recommended for either shallow-water or low-energy environments. Nor are they recommended in areas where biological resources could be adversely affected. Therefore, it is not likely that dispersants would be a first response for a spill in the Beaufort Sea. However, in Appendix C, we described the ongoing work to establish criteria for dispersant use in the Alaska OCS Region. It is up to the Alaska Regional Response Team (composed of State, local, and Federal officials) to define on an area-by-area basis the criteria under which dispersants may be applied in Alaskan waters.

Concern: The NSB stated the discussion of pipeline leak detection contained "several unsubstantiated statements concerning leak detection capability (i.e., leaks should be detected 'within a few hours to a day or two' and 'would be discovered within a matter of hours') which should be removed or supported by appropriate data." One individual also expressed concern about pipeline leaks in Cook Inlet.

Response: Our statements about leak detection are based on our experience in regulating offshore pipelines over many years and are entirely valid. Whether or not a leak is detected depends not only on the sensitivity of the detection system, but on whether the detection system is being monitored with adequate frequency. There have been a number of offshore pipeline spills that would have been detected much sooner if only the operators had either monitored their leak detection system more frequently or had a cross-checking system, such as volumetric line mass balance comparisons.

Every pipeline system is different and has its own set of complexities (e.g., transient production surges, multiple flow sources, multiple terminuses, etc.). Therefore, it is essential that each operator be familiar with the eccentricities of its system and *frequently* monitor that system for anomalies that might indicate the occurrence of a leak. In Appendix C (Section C.8.c) we outlined several methods for checking a pipeline system for leaks. (For example, we explained that to detect leak rates that are less than the threshold for direct leak detection, we could require that a volumetric line mass balance comparison of line inflows and outflows be conducted at least daily or at several intervals over the course of a day.)

British Petroleum's (BP's) Northstar pipelines in the Beaufort Sea are pigable and have a computerized supervisory control and data acquisition system for leak detection. Offshore segments of the pipelines are isolated by valves on the Northstar Island and at the shore crossings. At its Northstar facility, BP is using two additional methods to ensure that small leaks do not go on undetected for extended periods of time. BP has installed the LEOS detection system, which is placed next to the pipeline in the trench and should have the ability to detect spills as low as 1 barrel of oil per day. On a monthly basis, BP also conducts through-ice inspections along the length of the offshore pipeline to increase the chances of detecting a release.

Concern: The State of Florida's DEP commented that the discussion of dispersant use in Appendix C (Section C.7.g.) did not recognize the planning efforts USEPA Region IV for dispersant and in situ burning pre-authorization. They noted that Region IV has been active in these efforts and granted pre-authorization to the Federal On-Scene Coordinator in offshore waters. The DEP further stated that "Dispersant use in the Gulf of Mexico has gained State acceptance as reflected by pre-authorizations in both USEPA Regions IV and VI." Florida noted that they led the effort to grant dispersant use authority to the Federal On-Scene Coordinator within the States.

Response: We amended Section C.7.g. of Appendix C to reflect the DEP's comments.

Concern: The State of California commented: "The final EIS should discuss, state-by-state, and for British Columbia, recent (within the last decade) regulatory and policy advances in oil spill response. These should cover both mechanical (e.g., booming, skimming) and alternative (e.g., *in situ* burn, chemical dispersant) response technologies. This analysis should also include the dispersants use policy currently being revised for application in California."

Response: Appendix C, Oil-Spill Response Capabilities for Offshore Oil and Gas Operations, has been updated for each of the last three 5-year leasing programs and, therefore, already does reflect the regulatory, policy, and technical improvements in oil-spill response over the past decade.

Appendix C also contains a discussion of the major oil-spill response organizations and their locations in coastal areas of the United States. There is no reason to define spill response assets state-by-state because use of these assets is governed by Regional Response Teams (RRT's), Regional Contingency Plans, Area Contingency Plans (ACP's), and OSRP of individual lessees.

No OSRP's for offshore California will be filed as a result of this proposed 5-year leasing program, because no OCS areas in the Pacific Region are being considered for leasing. Therefore, we limited the scope of the environmental description and analysis on the west coast to only the potential impacts from tankers carrying oil from the Alaska OCS to west coast ports. At this stage in the program, it is highly uncertain how much oil will be tankered along the west coast, what routes those tankers would take, or what ports they would enter. In light of this uncertainty, we had no basis for developing more explicit scenarios of potential OCS tanker activity along the west coast.

Concerning dispersant use policy, in 1994, the Region IX (California, Arizona and Nevada) RRT developed a "Quick Approval Zone Plan" to expedite dispersant use in the offshore waters of California. In 2000, after receiving two requests for the pre approval for the use of dispersants in Federal waters, the Region IX RRT formed a Dispersant Subcommittee to review the "Quick Approval Zone Plan" and make recommendation to further streamline the dispersant approval process for oil spills in Federal waters. The Dispersant Subcommittee made the recommendation that each of the six ACP Committees for the State of California develop dispersant plans. Each plan would outline three zones: pre-approval for dispersant use (no RRT consultation needed), pre-Approval with consultation (consult with identified resource manager prior to approval), and RRT concurrence ("Quick Approval Zone Plan").

Region IX RRT accepted the recommendation of the Dispersant Subcommittee and the ACP Committees are currently completing the development of their Area Dispersant Plans. These plans are scheduled to be presented to the Region IX RRT at the July 2002 meeting.

ISSUE 13: Evaluate additional alternatives.

Issue Was Raised By: State of Alabama, Governor Don Siegelman; North Slope Borough (NSB), Mayor George N. Ahmaogak, Sr.; Independent Petroleum Association of America; The Ocean Conservancy, et al.; Barrow, Alaska, public hearing testimony.

Concern: The State of Alabama requested that all blocks south of and within 15 miles of Baldwin County be excluded from the proposed action.

Response: Blocks in the Eastern Gulf of Mexico Planning Area that are within 15 miles of the coast are not included in the proposed 5-year program. However, in the Central Gulf of Mexico Planning Area, the proposed program does include blocks within 15 miles of Baldwin County. Those blocks will be offered with a stipulation developed by MMS and the Alabama Geological Survey/Oil and Gas Board to minimize potential visual impacts. The stipulation, which is summarized in Appendix D, has been in effect for central Gulf sales since 1999. We will continue to work closely with the State on a sale-by-sale basis to address the mitigation of potential visual impacts.

Concern: The Independent Petroleum Association of America claimed there is no environmentally justifiable reason to limit the proposed program area in the Eastern Gulf of Mexico and recommended expanding the program area to include the blocks originally considered for Sale 181.

Response: Factors other than environmental concerns are weighed in determining the program areas to be considered for leasing in the 2002-2007 Program. The concerns expressed by coastal residents in the State of Florida and the wishes of the Governor of Florida were a major factor in establishing the program area in the eastern Gulf of Mexico. Evaluating an alternative that expands this area would not be reasonable.

Concern: The NSB recommended that the EIS analyze an alternative the would defer the spring lead system around Barrow Point, the eastern Alaskan Beaufort Sea, and waters in the vicinity of Cross Island. The Ocean Conservancy et al., claimed that the draft EIS did not consider a reasonable range of alternatives in terms of the number and size of lease sales in Alaska. In particular, they recommended we delete, or consider alternatives to delete, all blocks offshore the Alaska National Wildlife Refuge (ANWR), the Chukchi polynya, blocks offshore Barrow and along the coast near Teshekpuk Lake, and ultimately the entire Beaufort Sea Planning Area. Several testifiers at the Barrow public hearing asked that additional areas be removed from the proposed program area in the Beaufort Sea. Specifically, they wanted to have permanently removed from the OCS program those areas deleted from previous sales, an area around Cross Island, areas where bowhead whale subsistence harvesting and hunting occur, and blocks offshore ANWR.

Response: We considered requests to evaluate alternatives that would exclude additional portions of the Beaufort Sea Planning Area during scoping for the EIS (see Section 1.2.4.1). As stated in the scoping discussion, the 5-year program identifies the planning areas where lease sales will be scheduled during the 2002-2007 period, specifies how many sales will be considered, and broadly defines the portion of each planning area designated for subsequent leasing consideration. A decision to remove additional specific blocks requires a more site-specific analysis, which will be conducted at the lease sale stage. At that time, we may have new information to support decisions about deletions or mitigation that differ from decisions for previous sales. For that reason, we need to preserve the opportunity to use the most current information for lease sale decisions. We will consider the recommendations of the NSB, The Ocean Conservancy et al., and the testimony provided at the Barrow hearing in our subsequent sale analysis, and we will also take into account any additional comments regarding these issues received from the public during the lease-sale planning process.

ISSUE 14. Develop additional mitigation measures.

Issue Was Raised By: State of Alaska; The North Slope Borough (NSB), Mayor George N. Ahmaogak, Sr.; Alaska Eskimo Whaling Commission (AEWC); The Ocean Conservancy et al.; Environmental Defense; Barrow, Alaska public hearing testimony.

Concern: The AEWC questioned the statement in Section 1.2, "…none of the mitigation measures identified during scoping are analyzed in this EIS." Along with identifying resources to be analyzed and alternatives to be examined in the EIS, some commenters identified mitigation measures they considered necessary for environmentally safe operations in certain OCS areas.

Response: It is too early in the planning process at the 5-year program stage to evaluate particular mitigation measures. Depending on the results of the 5-year program planning process, some of the suggested measures may not be necessary. Most mitigation measures are designed for particular geographic areas or for specific proposed activities, and they are developed at the lease-sale stage or at the time MMS reviews plans submitted by operators. The wording and contents of some measures used previously may change through time with the development of technology, or agreements with affected State governments, agencies with expertise, and industry. The suggested measures will be kept on file and will be used during the preparation of appropriate lease sale EIS's.

Concern: The State of Alaska suggested that lease-sale mitigation measures should require appropriate oil-spill prevention measures.

Response: The development of mitigation measures to be applied to blocks leased in OCS lease sales is an important part of the planning and NEPA process. Requirements for oil-spill prevention are placed upon the lessee and operators through the Oil Pollution Act of 1990, MMS's operational regulations, and occasionally through sale-specific stipulations attached to leases. Oil spill prevention and cleanup, in the form of a required oil-spill response plan, is also the subject of consideration before the approval of exploration and development plans, and pipeline permits. In order that the latest technology can be incorporated into those plans, MMS develops them at the stage in the planning of activities where actual drilling and construction activity is under consideration for approval.

Concern: The Ocean Conservancy et al., stated that the draft EIS failed to evaluate lease-sale stipulations such as seasonal drilling restrictions, noise buffers, or pipeline technology, and failed to analyze the environmental impacts of imposing mitigation measures. The NSB recommended expansion of the Cross Island exclusion zone in the stipulation used in previous Beaufort Sea sales.

Response: Lease-sale stipulations are developed at the time the MMS, States, interested parties, and industry are going through the lease sale planning process. Stipulations developed at that time can be more specific to the needs of the particular sale area, the latest developments in technology, and knowledge about the species and habitats that may potentially be threatened by oil spills. The 5-year program EIS largely examines whether or not to place proposed lease sales on a schedule and considers the number and general size of sales to be proposed in a given planning area. The EIS's and other planning documents prepared for specific activities proposed in a planning area are better suited to evaluating the beneficial effects of applying mitigation measures, and balancing those benefits against the environmental impacts of the application of the mitigation measures themselves. Information provided by comments, such as the reasons for expanding the Cross Island exclusion zone, will be considered by MMS during the EIS process for the Beaufort Sea sales.

Concern: Environmental Defense stated that the 5-year program and the draft EIS failed to address the need for special mitigation measures necessary to allow exploration, development and production of resources in difficult conditions such as the Alaskan arctic, or very deep waters in the Gulf of Mexico.

Response: Mitigation measures, which are necessary to allow safe operations in special environments in different OCS planning areas, are discussed and evaluated in detail in NEPA documents prepared for lease sales or operations in those areas. It is premature to attempt to determine which measures will be necessary during the 5-year program so that they can be discussed and evaluated in this EIS. Even so, some measures were addressed in a generic sense in the draft EIS. Appendix C, Oil-Spill Response Capabilities For Offshore Oil And Gas Operations, addresses oil-spill and prevention and cleanup requirements and capabilities in the environments under consideration for leasing in this proposed program, and contains special sections such as, "Oil-Spill Issues Raised by Arctic Oil and Gas Development."

Concern: Environmental Defense stated that the 5-year OCS Program and EIS fail to identify and evaluate the efficiency of mitigation measures concerning oil-spill cleanup technologies, air quality controls, or marine discharges.

Response: Appendix C discusses the efficiency of oil-spill cleanup technologies generally. The effectiveness of mitigation measures is discussed in NEPA documents prepared for specific lease sales or projects, when specific measures will be considered for approval in light of the needs of the project and its local environment.

Concern: Testifiers at the Barrow, Alaska, public hearings said that the EIS didn't address the need for mitigating impacts of activities resulting from past lease sales in planning areas such as the Beaufort Sea.

Response: Unless laws or regulations have been broken by the operator in causing the impacts, MMS has no authority to remediate or force the operator to repair impacts from prior lease-sale activities. For information on impact assistance, revenue sharing, and incorporating funding for coastal impacts in the 5-year program or the agency budget, see Issue 31: Economic impacts including revenue sharing.

ISSUE 15: Impacts related to environmental justice.

Issue Was Raised By: Alaska Eskimo Whaling Commission (AEWC), Barrow Alaska; U.S. Environmental Protection Agency (USEPA), Office of Enforcement and Compliance Assurance; Marc Olsen; New Orleans Public Hearing; Port Graham Council.

Concern: A concern of several commenters was that environmental justice was not adequately addressed in terms of process/assessment issues and possible mitigation.

Response: Mitigation at the 5-year program stage is considered at a broad level in terms of the timing and general location of proposed leasing. Subsequently, mitigation measures will be developed for various lease sales in specific geographic locations. For example some mitigation measures related to environmental justice and sociocultural systems used in Lease Sale 170 were: 1) conflict avoidance mechanisms to protect subsistence whaling and other subsistence activities; 2) permanent facility siting in the vicinity of Cross Island; 3) industry site-specific Bowhead Whale-Monitoring Program; 4) information on community participation in operations planning; 5) the availability of bowhead whales for subsistence hunting activities; and 6) information on sensitive areas to be considered in the oil-spill contingency plans. For the 5-year program EIS analysis, we assume numbers two and five will be adopted (see Appendix D). For future lease sales, additional mitigation, as discussed above, may also be adopted.

Environmental justice and sociocultural research and analysis will continue to be conducted for these subsequent decision documents which will lead to additional mitigation. A new research effort titled "*Subsistence Mapping: Nuiqsut, Kaktovik, and Barrow*" will be beginning in 2002. This study involves the development of a Geographic Information System to support geospatial description of subsistence-oriented hunting and fishing activities undertaken by residents of the Alaskan North Slope. System development will focus on generating valid geo-spatial description of contemporary subsistence patterns, and will be configured to enable analysis of the changes in those patterns over time. Indeed, we would welcome dialogue with the USEPA and other interested parties concerning this important topic.

Concern: In the second paragraph on page 4-296 (Section 4.8.3.15.) in the draft EIS, AEWC reviewers suggested that MMS made the argument that "employment" opportunities might offset adverse impacts of development.

Response: Paragraph two on page 4-296 of the draft EIS suggests that economic benefits in general and Alaska and Native hire preference programs are important in order to create more economic opportunities for the communities in proximity to development as well as for individuals. In fact, few Natives work in the oil and gas industry, and hire preference programs can aid in promoting economic opportunity. In addition, revenues from oil and gas development have led to many economic benefits in the North Slope communities such as subsidized housing, schools, health care facilities, infrastructure and jobs, etc. These jobs are not directly in the oil and gas industry but are salaried through the local, State, and Federal Government as a result of revenues from oil and gas development.

Concern: A commenter at the public hearing in New Orleans stated that impacts on local communities could create various social problems specifically related to an MMS report (Seydlitz and Laska, 1994).

Response: The MMS financed this report in response to an immediate price collapse. Since the time of the report, MMS social scientists have reviewed literature in this area and are reconsidering the findings. We believe the relationships or correlations stated in the report are not endemic to the oil and gas industry and may be spurious. Thus, they would exist during rapid change or volatile times in many industries. We are currently conducting a new study to examine the relationship between the oil and gas industry and social dysfunctions. We have hired a well-known Louisiana sociologist to conduct the research. Early authors of sociology, such as Emile Durkheim, explain dysfunction such as this in terms of a lack of social cohesion. Thus, you will find higher suicide rates anywhere or any time a lack of social cohesion exists. Many different types of social disruption can lead to an abating of social cohesion.

In Wallace (2001) researchers found that the covariations as described in Seydlitz and Laska (1994) were not stable indicators during the few years prior to and after the bust. They did not covary before or since that period. Overall, MMS social scientists believe these relationships are not causal and more than likely spurious.

ISSUE 16. Analysis for CZM programs and procedures is incomplete or inadequate.

Issue Was Raised By: State of Louisiana, Department of Natural Resources, Coastal Management Division; North Slope Borough (NSB), Mayor George N. Ahmaogak, Sr.; Environmental Defense.

Concern: The State of Louisiana requested that MMS submit a consistency determination for the proposed 5-year leasing program.

Response: The MMS position on preparing a consistency determination for the 5-year program can be found in the final proposed program document.

Concern: The Environmental Defense claimed that the draft EIS failed to: (1) quantify the direct and indirect effects of activities anticipated to occur as a result of the 5-Year Program on the land and water uses in the coastal zone of all impacted states and (2) describe how the 5-year program intends to comply with the Coastal Zone Management Act (CZMA).

Response: We believe the EIS is in full compliance with the NEPA and its implementing regulations. Chapter 4 of the EIS fully describes the proposal's potential direct and indirect impacts on the land and water resources of the coastal zone including terrestrial mammals, coastal habitats, marine mammals, and water quality. We agree that the draft EIS does not describe how the 5-year program will comply with the CZMA. The MMS position for the 5-year program and CZMA compliance can be found in the final proposed program document, not in the EIS.

Concern: The NSB stated that exploratory drilling operations during the fall whaling season would be inconsistent with the provisions of the NSB Coastal Management Program that prohibit development that prevents subsistence-user access to a subsistence resource.

Response: The analysis in the draft EIS supports a program-level planning decision for considering future OCS leasing proposals. The decisions on the proposed 5-year program do not include decisions to allow drilling on OCS leases. Consideration of site-specific exploratory drilling operations on coastal management program provisions comes at a later stage in the OCS Program. When an OCS exploration plan is submitted to MMS for review, the lessee attaches a consistency certification stating that the proposed OCS exploratory activities comply with and will be conducted in a manner consistent with the enforceable policies of the coastal management program. The MMS sends a copy of the exploration plan and certification to the affected State's coastal agency for Federal consistency review and decision. The State decides whether the exploration plan is consistent with enforceable policies of its program. The State must concur with or object to the lessee's consistency certification within a designated time period. As there is not a specific exploration plan before MMS for review and consideration at the 5-year program stage, any evaluation of Federal consistency for exploratory drilling is premature.

ISSUE 17: Disposal, behavior, and effects of drilling and production wastes.

Issue Was Raised By: New Orleans, Louisiana, public hearing testimony.

Concern: One testifier at the New Orleans, Louisiana, public hearing claimed that most of the waste muds and cuttings generated by drilling operations are dumped untreated into surrounding waters, and significant elevations of certain metals (including mercury, cadmium and lead) contained in these muds and cuttings have been observed around drilling sites.

Response: The USEPA regulates through National Pollutant Discharge Elimination System (NPDES) Permits the discharge of drilling fluids and drill cuttings from oil- and gas-related activities. The discharge of non-aqueous drilling fluids is prohibited. Drill cuttings associated with non-aqueous drilling fluids can be discharged as long as specific effluent limitations with regard to mercury, cadmium and polynuclear aromatic hydrocarbons are met. Water-based drilling fluids and associated cuttings may be discharged if they meet specific toxicity tests, have no free oil, contain no diesel oil, and meet the same specific effluent limitations for mercury and cadmium as required for the discharge of non-aqueous drill cuttings. This information was published in the Federal Register (66 FR 6850). The EIS analysis assumes all discharges of muds and cuttings are conducted in accordance with EPA NPDES regulations.

ISSUE 18: Impacts on water quality.

Issue Was Raised By: The State of Florida; Port Graham Village Council; Cook Inlet Keeper; Ocean Conservancy et al.; New Orleans Group of the Sierra Club; Environmental Defense; Anchorage, Alaska, public hearing testimony; New Orleans, Louisiana, public hearing testimony.

Concern: The State of Florida questioned whether there might be more recent data than the early to mid-1990's data used for the water quality analysis in the draft EIS, especially concerning hypoxic conditions in the Gulf.

Response: The literature cited on hypoxia in the Gulf of Mexico was published between 1992-1996. We strive to use the best and most recent data available at the time a particular NEPA analysis is conducted. We believe the data from the documents used are both timely and beneficial. The MMS is currently developing a study designed to focus on understanding the processes that maintain oxygen levels in the deep Gulf of Mexico which should provide a further update on the issue of hypoxia in the Gulf of Mexico. Data from that study and other research that become available will be used in future NEPA analyses in the Gulf of Mexico.

Concern: The State of Florida pointed out that we acknowledge in the draft EIS that there has been relatively little evaluation of anthropogenic inputs to the Gulf of Mexico slope area and limited data available regarding trace element concentrations in the deepwater Gulf of Mexico.

Response: While it is correct that there has been relatively little evaluation of anthropogenic inputs to the Gulf of Mexico slope area, this was due in part to the distance of the slope area from potential input sources and to the reality that processes that would transport contaminants over that distance would likely spread and consequently dilute the contamination over a large area. While limited, there is trace element data available for the deepwater Gulf, as stated in the draft EIS. A publication by Boyle et al. (1984) suggests minimal anthropogenic inputs to deep water compared to nearshore waters. In addition, MMS is currently funding one study analyzing the effects of oil and gas exploration and development at selected continental slope sites in the Gulf and another study that relies, in part, on the results of a recently begun screening survey conducted cooperatively by industry and the USEPA. The results of these two studies will be used in subsequent analyses for proposed sales and projects in the Gulf of Mexico.

Concern: The New Orleans group of the Sierra Club wanted to know whether any further studies have been conducted as a follow-up to the 1988 report by Kennicutt which discussed elevated organic compounds of environmental concern in the north Gulf of Mexico offshore waters or whether this is the extent of the work on this issue.

Response: We are continuing to fund several studies that address potential environmental impacts from offshore oil and gas activities. We have recently completed a study on *Environmental Impacts of Synthetic Based Drilling Muds* which includes water column and sediment toxicity testing as well as bioaccumulation tests in bivalve mollusks. We will also be considering as a possible area of study trace element analysis in our future research planning program.

Concern: Environmental Defense stated that the draft EIS failed to include an evaluation of recent data derived from studies of the *Exxon Valdez* oil spill, in which very low levels of polyaromatic hydrocarbon (PAH) compounds in Alaskan waters have been found to cause life cycle mutagenic effects on the eggs of pink salmon.

Response: Recent data published on long-term impacts to pink salmon from exposure to PAH's is discussed in Section 4.3.3.6.2. Accidents (Sublethal and Chronic Effects).

Concern: Environmental Defense argued that the EIS must describe how activities resulting from the proposed program will comply with relevant sections of the Clean Water Act, and that the fates and effects of heavy metals associated with drilling discharges must be evaluated. Environmental Defense and a testifier at the New Orleans, Louisiana, public hearing claimed that produced water impacts resulting from the discharge of toxic pollutants including benzene, arsenic, lead, ethylene, naphthalene, zinc, toluene, and radium down current from the discharge and must be quantified, and mitigation must be identified in the EIS.

Response: In compliance with the Clean Water Act, the USEPA regulates the discharge of drilling fluids and produced water from oil- and gas-related activities through the issuance of National Pollutant Discharge Elimination System (NPDES) permits. In the Offshore Guidelines, the USEPA controls pollutants in produced water by limiting oil and grease to a 29-milligrams-per-liter (mg/l) monthly average and a 42-mg/l daily maximum. Oil and grease serve as indicators for toxic pollutants in the produced water waste stream, including phenol, naphthalene, ethylbenzene, and toluene. The USEPA determined that it was not technically feasible to control these toxic pollutants specifically, and that limitations on oil and grease in produced water reflect control of these toxic pollutants at the best available technology and New Source Performance Standards levels. This information is as published in the USEPA's *Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Offshore Subcategory of the Oil and Gas Extraction Point Source Category*, dated January 1993. This EIS and NEPA analyses conducted for all OCS oil and gas proposals assume that NPDES permits issued by the USEPA are in place and provide mitigation of impacts from the discharge of produced water and other effluents.

Concern: The New Orleans group of the Sierra Club acknowledged the discussion in the draft EIS on red tides and the possible impact of human activity on the formation of red tides. They would like to see more research conducted on the issue of red tides and wanted to know what relevant research projects MMS is currently funding.

Response: USEPA is funding ongoing studies of red tides to determine whether human activity that increases nutrient loading to Gulf of Mexico waters is contributing to the frequency and intensity of red tides. Currently, the MMS is not funding research on red tides. We discuss the effects of red tides on other marine organisms as a part of the description of the affected environment of the Gulf of Mexico. We will consider the results of USEPA's studies, as appropriate, in the cumulative analysis for future oil and gas proposals in the Gulf of Mexico.

Concern: A commenter from the Port Graham Village Council objects to the use of the word "pristine" when describing the general water quality of the Norton Basin Planning Area.

Response: We also noted that in the shallow area of Norton Sound the water is turbid, especially near the outflow from the Yukon River on the south side of the sound. However, in overall terms, we believe it is appropriate to state that the general water quality in the Norton Basin Planning Area is pristine.

Concern: Cook Inlet Keeper claimed that, without a better understanding of the impacts of current Cook Inlet offshore oil and gas operations, MMS should not add to those impacts through discharges from new drilling operations.

Response: We have provided an analysis of the impacts of current Cook Inlet offshore oil and gas operations (Section 4.8.3.1. Water Quality). An EIS specific to Cook Inlet will be prepared if sales in Cook Inlet are included in the 2002-2007 program. That NEPA analysis will evaluate in detail the potential incremental impacts of additional leasing on the water quality in Cook Inlet. The decision for each lease sale will take into account all impacts described in the relevant EIS, including the potential impacts on water quality from the sale as well as from cumulative activities.

Concern: Cook Inlet Keeper was concerned that MMS cited sediment quality and depositional areas of Shelikof Strait in the Cook Inlet final report that was done recently as proof that upper Cook Inlet oil and gas production would have no discernible environmental effects in the report's study area. However, the study area was 150 miles south of the nearest oil and gas effluent discharge point and therefore the results are not applicable.

Response: We have previously conducted studies which included analysis of sediments collected from upper Cook Inlet in State waters. Field research for the OCS study, "*Current Water Quality in Cook Inlet, Alaska, Study,*" (Environment and Natural Resources Institute, 1995) was conducted in 1993 and included numerous sampling sites in a variety of Cook Inlet environments in the vicinity of the production platform. It was conducted by the University of Alaska Environmental and Natural Resources Institute and collected seawater, sediments, and biota for detailed chemical analysis and bioassays. This study concluded that Cook Inlet has a very low environmental concentration of hydrocarbons and that the sediments and waters are generally free from toxicity. In 1997 and 1998, MMS also completed two other relevant studies: "*Sediment Quality in Depositional Areas of Shelikof Strait and Outermost Cook Inlet, Final Literature Synthesis*" (Boehm et al, 1998) and "*Interaction Between Marine Humic Matter and Polycyclic Aromatic Hydrocarbons in Lower Cook Inlet and Port Valdez, Alaska*" (Shaw et al., 1998.) The University of Alaska, Environmental and Natural Resources Institute, as well as the MMS Scientific Advisory Committee recommended that MMS conduct sediment sampling further "downstream" from the drill sites where the sediments were actually being deposited. Samples were taken from sites in Cook Inlet and Shelikof Strait with additional sampling stations in the Gulf of Alaska. Shaw et al. (1998) evaluated the amount of petroleum-related compounds and other metals present in the sediment, sediment cores, fish tissue, and source samples. Sediment cores were obtained and analyzed, which span a depth of time that predate oil and gas activities in Cook Inlet. As stated in Environmental and Natural Resource Institute (1995), the concentrations, compositions, and sources of contaminants in the study area have not increased significantly since oil and gas development began in Cook Inlet in 1963. We are confident that the study sites have been appropriately chosen and that the results are both accurate and relevant.

ISSUE 19: Impacts on air quality.

Issue Was Raised By: U.S. Environmental Protection Agency (USEPA), Office of Enforcement and Compliance Assurance; Environmental Defense; The Ocean Conservancy, et al.; New Orleans, Louisiana, public hearing testimony.

Concern: The USEPA stated that more discussion is needed regarding (1) air quality impacts on Gulf Coast ozone nonattainment areas, (2) any problems in meeting air conformity requirements, and (3) the likelihood that emission offsets may be required as a result of activities associated with the proposed leasing program. The Environmental Defense expressed the need to evaluate the likelihood that the OCS activities would comply with the Federal Clean Air Act (CAA) as well as regional air quality standards.

Response: The Gulf of Mexico Air Quality Study, which was cited in the draft EIS analysis (sections 4.3.2.2 and 4.8.2.2), showed that the impacts from OCS emission sources on ozone levels in the Gulf Coast nonattainment areas are very small. Based on the results of the study, the MMS, in consultation with the USEPA, concluded that no changes were needed in the MMS air quality regulations. Therefore, no emission offset requirements apply to new OCS emission sources. Emission sources in OCS waters are not subject to conformity requirements because they occur outside the nonattainment area boundaries and are, therefore, not counted in the State Implementation Plan emissions budget. However, any OCS-related emissions that occur in State waters, such as those arising from pipeline installation projects or significant increases in vessel traffic, may be subject to conformity requirements. There have been very few cases in the Gulf where a conformity determination was required. We expect that any future conformity determination cases will continue to be infrequent. Each one will be analyzed on a case-by-case basis.

We acknowledged in the draft EIS that the impacts of OCS emissions would need to be reevaluated following implementation of the Federal 8-hour ozone standard. Following further studies, the MMS will determine if mitigation requirements will be needed.

The air quality analyses in the EIS evaluates the effect of OCS emissions on the ability of the onshore regions to comply with the ambient air quality standards and the pollution limits allowed under the Prevention of Significant Deterioration (PSD) regulations. The analysis in Section 4.3.2.2 shows that emissions from the proposed OCS activities would not contribute significantly to air quality levels in the nonattainment areas. Also, modeling analyses described in Sections 4.3.2.2 and 4.3.3.2 show that the OCS emissions would not cause any exceeding of the maximum allowable concentration increases in the attainment areas under the PSD regulations. The OCS facilities in the Alaska Region and in the Gulf of Mexico Region east of 87.5° W. longitude would be regulated by the USEPA.

Concern: The Ocean Conservancy, et al., raised the issue of possible adverse health impacts to oil-spill cleanup workers, citing high levels of benzene present in North Slope crude oil.

Response: The modeling analysis for a large oil spill (see Section 4.3.2.2.2) took into account the level of benzene found in North Slope crude oil. The predicted emission rate for benzene reached its peak within 10 hours after the spill started and was reduced to very small quantities within 24 hours of the spill. Peak benzene concentrations occurred immediately after the spill commenced, but were reduced by two orders of magnitude within 12 hours. Concentrations of other hazardous compounds, such as ethylbenzene, toluene, o-xylene, and m&p-xylenes, also reached their maximum value within a few hours after initiation of the spill. For a spill that occurs in open water, the most volatile components of the crude oil will have evaporated before the oil reaches the shoreline, and any exposure of toxic air pollutants to cleanup personnel should be rather small. For an incident that occurs very close to shore and releases crude oil over an extended time, the exposure to hazardous contaminants in the air could be greater than for an open-water spill.

Concern: The Ocean Conservancy, et al., stated that the draft EIS did not adequately analyze the cumulative effect of new air emission sources, including greenhouse gases.

Response: The cumulative impacts on air quality in the draft EIS considered projected emissions from reasonably foreseeable future OCS oil and gas development as well as the effects of trends in onshore emissions. Greenhouse gas emissions were discussed in a separate section (section 4.1.2.) because greenhouse gases differ, in many respects, from the so-called criteria pollutants, such as nitrogen dioxide, sulfur dioxide (SO_2), and ozone. The latter are regulated under the CAA. The impacts are generally confined to certain geographic areas and the effects can be estimated based on the size and distribution of the emission sources and the meteorology. The pollutants are subject to ambient air quality standards to protect public health and welfare. The CAA prescribes specific emission regulations and sets deadlines to meet the ambient air quality standards. Greenhouse gas emissions are not regulated under the CAA or any other public law or directive. Their impacts are global, rather than just regional or local. The impacts caused by a continued increase in greenhouse gas levels in the atmosphere cannot yet be assessed with any reasonable measure of certainty. One cannot really assess impacts from greenhouse gas emissions from an individual project.

Concern: One testifier at the New Orleans public hearing stated that the draft EIS discussion did not include an analysis of flaring from offshore platforms. Another testifier at the New Orleans public hearing raised a concern regarding air quality impacts from exploratory drilling activities and from platforms.

Response: Flaring operations are conducted to vent gas during well testing or during the repair or installation of production equipment. The MMS restricts flaring to minimize the loss of natural gas resources. The MMS prohibits flaring for more than 48 hours unless the operator obtains specific approval for continuing beyond this timeframe. Flaring emissions are mostly in the form of nitrogen oxides, volatile organic compounds, and carbon monoxide. Emissions of SO_2 are usually very small unless the flare gas contains significant amounts of hydrogen sulfide (H_2S). There are a relatively small number of platforms in the Gulf of Mexico that produce sour gas (gas with a significant H_2S content). Some platforms that produce sour gas employ a gas sweetening unit for removing sulfur from the gas. If the waste gas stream is incinerated, emissions of SO_2 will be produced. If a sulfur recovery unit is used, the SO_2 emissions will not occur. Emissions from flaring and from gas sweetening units were included in the platform emissions used in the air quality impact analysis. The majority of the SO_2 emissions were attributed to either flaring or incineration. The impacts are described in the EIS (Sections 4.3.2.2 and 4.3.3.2). Emissions associated with exploratory drilling and production platforms were also included in the air quality analysis. The estimated drilling emissions are listed in Tables 4-8a-d (the proposed action) and Table 4-11 (cumulative). In the Gulf of Mexico, the majority of the emissions come from production platforms. Emissions from drilling are much lower than the production platform emissions.

ISSUE 20: Impacts on marine mammals.

Issue Was Raised By: State of Alaska; California Governor's Office; North Slope Borough; Alaska Eskimo Whaling Commission; Alaska Marine Conservation Council; Ocean Conservancy et al.; Barrow, Alaska public hearing testimony; Nome, Alaska public hearing testimony; and Anchorage, Alaska public hearing testimony.

Concern: An opinion was expressed by the North Slope Borough, the Alaska Eskimo Whaling Commission, and an individual from the Barrow public hearing that information on bowhead whales was neither accurate nor up to date.

Response: We believe that overall the descriptive information on bowhead whales in chapter 3 is accurate and up to date. We revised section 3.2.2.1. and 4.3.3.3. to clarify existing information and to incorporate additional recent information. For example, we added more detail to the migration discussion to highlight differences between the spring and fall migrations, and we referenced monitoring studies that indicate the 20 km displacement of bowheads during seismic operations. Regarding older information cited in the draft and final EIS, we continue to include that information, which remains valid. We will continue to review and incorporate new information into subsequent NEPA analyses.

Concern: The State of Alaska and an individual at the Anchorage public hearing stated that information on beluga whales was incomplete and that oil and gas leaks, drilling, and low-frequency acoustics from oil platform work will very much adversely affect the beluga whale. Alaska Marine Conservation Council and an individual at the Anchorage public hearing commented that the Cook

Inlet/Shelikof Strait area is home to the Cook Inlet stock of beluga whales, which was listed as depleted by the National Marine Fisheries Service.

Response: We revised section 3.2.2.1.2. to incorporate information on the eastern Bering Sea stock of beluga whales and add additional information on the Cook Inlet stock including its distribution, numbers, and listing as depleted. We disagree that routine industrial noise will very much adversely affect the beluga whale but we do agree that there is the potential for an oil spill under certain scenarios, to have serious, adverse effects on beluga whales. Section 4.3.3.3.1. concludes that routine operations could cause the Cook Inlet stock of beluga whale to experience minor to moderate impacts on the population and they could possibly face up to major impacts from oil spills.

Concern: The Mayor of Nome, Leo Rasmussen and another individual at the Nome, Alaska public hearing stated that polar bears are not likely to occur in the Norton Sound area.

Response: We revised section 3.2.2.1.2. to clarify that the seasonal presence of polar bears referred to the western and northern Norton Basin planning area (as defined in Figure 2-5) not Norton Sound.

Concern: The California Governor's Office felt the final EIS should include oil spill trajectory modeling. They commented that oil spill trajectory modeling, conducted for the draft Revised Recovery Plan for the Southern Sea Otter (*Enhydra lutris nereis*), indicated that spills off California's San Mateo coast would be expected, in many circumstances, to contact coastal waters, habitats, and sensitive and/or listed organisms of the California central coast.

Response: Section 4.3.4.3.3. states that impacts from accidental oil spill exposure along the central California coast would be unavoidable, should the oil reach nearshore coastal waters and associated sea otter habitat. The response to Issue 12 explains our method for analyzing oil spills and why we do not use our oil spill trajectory model for the 5-year program EIS.

Concern: The California Governor's Office and State of Alaska asked for section 3.2.2.1.2. to be revised to clarify that it is the Aleutian Islands population of Alaska sea otters that has declined 70 percent.

Response: This has been clarified in Section 3.2.2.1.2.

Concern: The State of Alaska commented that Section 4.3.3.3.3. did not include a discussion of the impacts of the *Exxon Valdez* oil spill on sea otter populations.

Response: The discussion of the impacts of the *Exxon Valdez* oil spill on sea otters is in section 4.3.4.3.3. We added additional discussion to section 4.3.3.3.3.

Concern: The North Slope Borough and the Ocean Conservancy et al. criticized the draft EIS analysis of impacts of oil spills on marine mammals as inadequate and misleading.

Response: We have considered additional references from the *Exxon Valdez* oil spill literature. After further review of the analyses and review of comments provided during the public comment period, we believe our analyses of the impacts of oil spills are valid. We did revise the analysis of impacts of oil spills to whales, pinnipeds, polar bears, and sea otters and changed the conclusion for oil spill impacts on killer whales from negligible to minor-to-moderate. The responses to Issue 12 explain further the scope of the oil spill analysis for this EIS, the assumptions used for the analysis, and why we do not do a worst-case analysis or oil spill trajectory modeling at this programmatic stage.

ISSUE 21: Impacts on terrestrial mammals.

Issue Was Raised By: The State of Alaska, Governor Tony Knowles; Ocean Conservancy et al.; Mr. Austin Ahmasuk; Nome, Alaska, public hearing testimony.

Concern: The Governor of Alaska requested that two text changes and additions be made in the EIS with regard to (1) the description of management responsibilities for Alaskan terrestrial mammals and (2) the use of coastal Cook Inlet and Kenai Peninsula areas by black and brown bears.

Response: The text in Sections 3.2.2.2 (Terrestrial Mammals) and 4.3.3.4.3 (Grizzly and Black Bears) was modified as requested.

Concern: The Ocean Conservancy et al., suggested that Figure 3-28 in the draft EIS should be modified to indicate the range of the Porcupine Caribou Herd extending west to the Canning/Staines River.

Response: We agree; the figure has been corrected.

Concern: Mr. Austin Ahmasuk stated that the EIS does not consider the low moose population in the Nome area resulting from sport hunting.

Response: The Nome area moose population would not be affected by the proposed OCS program and is, thus, not considered in the EIS.

Concern: Ms. Irene Anderson testified at the Nome, Alaska, public hearing that there are no black bears in the Nome area..

Response: The final EIS text has been modified to reflect this comment.

ISSUE 22: Impacts on marine and coastal birds.

Issue Was Raised By: State of Alaska; State of California, Governor Gray Davis; Ocean Conservancy et al.; and Barrow, Alaska, public hearing testimony.

Concern: The Ocean Conservancy et al., commented that the impact analysis of oil spills on marine and coastal birds was inadequate and should include discussion of the impacts of the *Exxon Valdez* oil spill.

Response: Additional information from the 2001 Exxon Valdez Oil Spill (EVOS) Trustee Council status report and other publications on the impacts of the *Exxon Valdez* oil spill on birds were added to Section 4.3.3.5.2.

Concern: The State of Alaska asked that additional information on the distribution of Steller's eiders, Pribilof Islands rock sandpiper, and nesting marbled and Kittlitz's murrelets be added to Section 3.2.2.3.2.

Response: Information on the numbers and distribution of Steller's eiders and the occurrence of Kittlitz's murrelets in Prince William Sound was added to Section 3.2.2.3.2. We did not address the Pribilof Islands rock sandpiper because we did not find additional information on that species other than it occurred within the action area.

Concern: An individual at the Barrow, Alaska, public hearing testified that, for some groups of birds, there was little to no information and for other species there was too much detail and that the section was confusing. It was suggested that more descriptive information and oil-spill analysis on the king and common eiders be included in the final EIS.

Response: Section 3.2.2.3.2 in the final EIS was revised to clarify the divisions between waterfowl, shorebirds, and seabirds and to present a balanced approach to those three divisions of marine and coastal birds. Additional descriptive information on king and common eiders was added to the final EIS. Specific information on the effects of the *Exxon Valdez* oil spill on marine and coastal birds was added to Section 4.3.3.5.2. That information did not include effects on king and common eiders.

Concern: The California's Governor's Office expressed the opinion that the draft EIS underestimated both the potential for an oil spill and the impact of spilled oil on birds.

Response: Additional information from the 2001 EVOS Trustee Council status report and other publications on the impacts of the *Exxon Valdez* oil spill on birds was added to Section 4.3.3.5.2. Regarding the potential for an oil spill, the reader is referred to Issue 12

ISSUE 23: Impacts on fish resources and essential fish habitat.

Issue Was Raised By: Ocean Conservancy, et al.; New Orleans, Louisiana, public hearing testimony

Concern: The Ocean Conservancy et al., and a testifier at the New Orleans, Louisiana, public hearing identified topics needing better treatment in the EIS including the toxicity of oil to commercially important fish species. They noted that scientists and National Marine Fisheries Service (NMFS) labs researching the *Exxon Valdez* oil spill found concentrations of polyaromatic hydrocarbons (PAH's) as low as one part per billion were toxic to juvenile pink salmon.

Response: Information on long-term impacts to pink salmon from exposure to PAH's is discussed in Section 4.3.3.6.2. Accidents (Sublethal and Chronic Effects). Information on oil toxicity in fish is discussed in this section as well.

Concern: The Ocean Conservancy et al., claimed that one of the more dramatic and unanticipated injuries from the *Exxon Valdez* oil spill occurred as the herring population in Prince William Sound collapsed after the settlement. An outbreak of viral hemorrhagic septicemia occurred in the herring population in 1993 and may have been associated with a depressed immune response. Based on this evidence, the commenter believes the EIS impacts could be at least moderate to major.

Response: Additional information on long-term impacts to Pacific herring has been added to section 4.3.3.6.2. Accidents (Sublethal and Chronic Effects). Brown et al. (1996) noted that genetic damage in larvae from oiled areas of Prince William Sound progressively decreased during their 6-week study. They also noted a significant reduction in larval production occurred in 1989. While there was an estimated substantial decrease in larval production, reduced abundance cannot be estimated because natural processes affecting recruitment are poorly understood. The definition of moderate impacts states that the viability of the affected resource is not threatened although some impacts may be irreversible or the affected resource would recover completely if proper mitigation were applied during the life of the project or proper remedial action were taken once the impacting agent was eliminated. Therefore, we conclude the analysis supports an impact level of minor to moderate.

Concern: The Ocean Conservancy et al., believes it is speculation and not based on science for the EIS to state that mobile fish would probably be frightened away from the area by approaching noise before the airgun comes within range.

Response: This information was not based on speculation but on published research. Turnpenny and Nedwell (1994) stated that adult fish would not be injured by airguns in an array unless they were immediately adjacent to an airgun. Prior to coming that close to the airguns, it is likely that fish would be driven away by the approaching noise source. Small fish could be injured at distances up to 1.5-3.0 meters from the airguns. This citation has been added to the final EIS.

Concern: The Ocean Conservancy et al., stated that there needs to be a full analysis of other key forage fish such as capelin, sand lance, lanternfish. Numerous benthic fish such as pricklebacks and blennies are of critical importance to marine food webs, and these keystone ecological species should be included as well. They also stated that the EIS should discuss how the *Exxon Valdez* oil spill affected not only pink salmon but their prey species as well.

Response: A complete ecological analysis of all species inhabiting an environment is not appropriate in this EIS. We make every effort to use the best information currently available when a particular NEPA analysis is conducted for a given proposal. As the results of additional studies are made available, we include these findings in our analysis. The effects of oil on fishes is discussed in Section 4.3.3.6.2. Accidents (Acute and Lethal Effects) and (Sublethal and Chronic Effects). Several species are discussed as well as the potential impacts of oil exposure at various life stages. It is noted that some fish spawn in intertidal zones where their eggs may be susceptible to oil.

Concern: The Ocean Conservancy et al., stated that the lower Cook Inlet and upper Shelikof Strait are critical spawning habitat for walleye pollock and that the EIS should highlight potential impacts in this region for one of Alaska's most preeminent commercial fish species.

Response: We have added walleye pollock to the paragraph in Section 4.3.3.9.1 that lists some of the fish species whose essential fish habitat (EFH) may be effected by drilling, dredging, and resulting sedimentation in Shelikof Strait.

Concern: Environmental Defense claimed that the 5-year program and the accompanying EIS fail to explain how activities conducted as a result of the program will comply with the Magnuson-Stevens Fishery Conservation and Management Act (FCMA). The program and EIS must quantify and identify the locations of biological resources comprising EFH within all project impact areas and identify specific locations of EFH within the project areas. Effective mitigation measures for project-induced EFH impacts must be incorporated in the NEPA process.

Response: Section 305(b)(2) of the FCMA requires all Federal Agencies to consult with NMFS on all proposed actions, authorized, funded or undertaken by the Agency, that may adversely affect EFH. We are developing an agreement with NMFS to use the NEPA process at the lease-sale stage to complete EFH consultations for OCS actions. At that time, MMS will provide a description of the proposed action, an analysis of the potential adverse effects of the action on EFH and the managed species, conclusions regarding the effects of the action on EFH, and proposed mitigation, if applicable.

ISSUE 24. Impacts on coastal habitats.

Issue Was Raised By: State of Louisiana, Department of Natural Resources (LADNR); New Orleans, Louisiana, public hearing testimony.

Concern: Testimony was given at the public hearing in New Orleans, Louisiana, that a more detailed analysis of the magnitude of wetlands loss associated with OCS oil and gas development must be undertaken in the final EIS.

Response: We recognize that wetlands loss in an important concern along the Gulf of Mexico coast. However, we think that the more detailed discussion requested is better left to specific analyses of lease sale impacts and cumulative impacts. Information on the potential levels of activity resulting from discovery and production of oil and gas resources are described with greater certainty in the lease sale scenario and analysis. The EIS's and environmental assessments prepared on individual lease sales proposed in the Gulf of Mexico have, in the past, and will, in the future, provide more detail on the subject than is practical or possible in a programmatic EIS such as this one.

Concern: The statement was made at the New Orleans, Louisiana, public hearing that the draft EIS does not sufficiently cover possible pipeline routes that may be used in the future and their impacts on coastal wetlands.

Response: Predictions of miles of pipelines and numbers of landfalls developed in the scenario used in the preparation of this EIS are based strictly on anticipated volumes of oil and gas resources recovered as a result of the adoption of a particular alternative. At this stage of the planning process, we cannot determine where within a planning area oil or gas might be discovered and require new pipelines, nor is it possible to know which onshore facilities might be the terminus of such pipelines. To make estimates of specific pipeline routes at this time would be speculation that could lead local and State planning agencies to needlessly expend energy and funds to plan for pipeline corridors that may never materialize. Therefore, the analysis in this programmatic EIS is based on an estimated range of pipeline miles and the estimated number of pipeline landfalls that may result in each planning area if the amount of anticipated oil production is discovered and produced. More site-specific analysis of pipeline impacts will be conducted for proposed lease sales and specific development and production proposals.

Concern: The LADNR stated that MMS should review impacts to coastal wetlands predicted in earlier 5-year programs and lease sale documents and compare them to actual impacts which have resulted.

Response: The exploration, development, and production activities resulting from a particular lease sale in the Gulf of Mexico that could cause impacts to wetlands occur over a period of perhaps 40 years. These activities (and the resulting impacts) overlap with those occurring from other lease sales. Therefore, it is not possible to attribute impacts to the lease sales in any particular 5-year program. However, the EIS's prepared for lease sales in the Gulf of Mexico estimate the amount of wetlands impacts that can be attributed to OCS oil and gas activity generally and estimate the extent of future impacts to wetlands from OCS and non-OCS activities.

A series of studies were sponsored by MMS in the 1980's and 1990's to address this issue. The first study investigated the causes of wetland loss in the coastal central Gulf of Mexico (Turner and

Cahoon, 1987). The study examined the causes of the high rate of wetland loss and the contribution OCS activities have toward this loss. This was followed by a study which examined the impacts of OCS canals, navigation channels, and associated infrastructure on barrier islands and associated wetlands (Wicker, et. al., 1989). A third study assessed the effectiveness of mitigation of wetland impacts from oil and gas activities (Cahoon and Groat, 1990). The results of these studies have been used for the analyses in the EIS's prepared for Gulf of Mexico lease sales. We are presently conducting a study *entitled "Assessment of Changes to Coastal Habitat Associated with OCS-Related Pipelines, Navigation Canals, and Mitigation."* The study's investigators are comparing types and severity of adverse impacts caused by OCS-related canal projects in geologically distinct regions of the Western and Central Gulf of Mexico Planning Areas.

Concern: The LADNR suggested that the 5-year leasing program should include a process by which MMS would adequately compensate coastal States for secondary and cumulative impacts to coastal wetlands, or play a role in finding methods to adequately compensate affected States.

Response: Section 1.2.5.1 of the EIS explains the Department of the Interior's position concerning "revenue sharing" which can be used to compensate coastal States for impacts. The Department has supported the concept of a greater sharing of revenues with the States and communities most heavily affected by OCS oil and gas activities, as well as the principle of using impact assistance as a means of protecting coastal and marine resources and mitigating the environmental impacts of OCS activities. The previous Congress passed legislation that included, among other things, a coastal impact assistance program. As part of that legislation, they authorized $150 million for the program, but only for 1 year. The "Wildlife, Ocean and Coastal Conservation Program" calls for the Department of Commerce to distribute $150 million in FY 2001 to seven coastal States affected by OCS oil and gas activities. The legislation allows a State to use a portion of the monies it receives under the program to mitigate environmental impacts through funding onshore infrastructure projects and other public service needs. See Issue 28 for more on revenue sharing.

ISSUE 25: Impacts on seafloor habitats.

Issue Was Raised By: State of Florida, Department of Environmental Protection (DEP); Pinellas County Board of County Commissioners; Ocean Conservancy et al.

Concern: The Florida DEP suggested that the draft EIS be updated to include recent information on eastern Gulf of Mexico live bottom resources in water depths greater than 100 meters (m).

Response: The MMS has evaluated the information on hard bottom habitats provided by the video surveys conducted for the Gulfstream Pipeline Project as referenced in the Florida comment. The Benthic Habitat Survey Report prepared for the Gulfstream Pipeline Project described all four areas surveyed by a remotely operated vehicle. The areas surveyed, however, were all in water depths of less than 100 m. The high-relief pinnacle features that were observed in the deepest areas surveyed (95 m) are primarily exposed rock and are not populated by the diverse association of attached organisms characteristic of true "live bottoms." Subsequent analyses prepared for specific lease sales will consider any new information that becomes available on the distribution and composition of live bottom communities in the Gulf of Mexico Planning Areas.

Concern: The Pinellas County Board of County Commissioners stated that it does not support conclusions that most impacts to seagrass beds from small and large oil spills would be short-lived.

Response: The analysis of environmental consequences provided in Chapter 4 of the draft EIS does not conclude that impacts to seagrass beds from large and small oil spills would be short-lived. In the analysis of environmental impacts of the proposed action (Section 4.3.2.9.3), the conclusion states that "overall impacts of oil spills contacting submerged seagrass beds would be minor to moderate." These impact levels are not defined as short-lived (see Section 4.2.1). The conclusion of a minor impact level on submerged seagrass beds from small oil spills is based on two factors: (1) most impacts to the affected resource could be avoided with proper mitigation; and (2) if impacts were to occur, the affected resource would recover completely without any mitigation once the impacting agent was eliminated. The MMS agrees that recovery times for damaged seagrass beds are not short-term.

Concern: The Ocean Conservancy et al., requested that MMS provide supporting scientific evidence that the boulder patch would probably recover quickly from minor changes in turbidity and sedimentation.

Response: The conclusion of Section 4.3.3.8 of the draft EIS states that "impacts due to turbidity and sedimentation on the Stefansson Sound Boulder Patch community could range from negligible to moderate, depending on the actual location of any proposed development." The statement that the boulder patch community would probably recover quickly from minor changes in turbidity and sedimentation is not based on a specific scientific reference. Rather, it represents the EIS analyst's judgment based on consideration of a large body of information. In addition to the biological impacts discussed in Section 4.3.3.8 of the draft EIS, Section 4.3.3.1 (Water Quality) suggests that the temporary, additional suspended sediment load caused by routine activities, including dredging for pipelines and construction of artificial islands, will have minor impacts on water quality. Furthermore, major offshore production facilities such as the Northstar facility, now producing oil in the Beaufort Sea, will be reinjecting drilling muds, cuttings, and production waters. This procedure eliminates degradation of water quality and any consequent harm to the boulder patch community by drilling effluents. New information is being collected on the boulder patch community as part of the MMS-sponsored study *"Arctic Nearshore Impact Monitoring in Development Area."* Subsequent EIS analyses prepared on a more specific lease-sale basis for the Beaufort Sea will consider all new available information concerning potential harm to the boulder patch community.

ISSUE 26: Impacts on global climate change.

Issue Was Raised By: Environmental Defense; Ocean Conservancy et al.; Wanda Ballentine; New Orleans, Louisiana, public hearing testimony, Anchorage, Alaska, public hearing testimony.

Concern: Several commenters expressed great concern about greenhouse gas emissions and their impact on the environment, and thought that the draft EIS did not discuss these impacts thoroughly enough. The Ocean Conservancy et al., stated that the draft EIS did not discuss the negative effects of climate change on the arctic ecosystem, Native subsistence, beach erosion, permafrost, and the safety and integrity of offshore infrastructures. A testifier at the New Orleans, Louisiana, public hearing stated that the EIS should discuss the effect of sea-level rise on onshore pipelines that would be submerged.

Response: The EIS presents a general discussion of the effects of global climate change Section 4.1.2). A comprehensive discussion is not possible because of the very complex interactions among the atmosphere, oceans, and the biosphere. The recent publications by the Intergovernmental Panel on Climate Change present a comprehensive discussion of global climate change impacts. An assessment of global climate change on the United States is given in a 2000 report *entitled "Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change, Overview"* prepared by the National Assessment Synthesis Team of the U.S. Global Change Research Program.

In this EIS, we focused on Alaska and the Gulf of Mexico because these are the areas where the proposed OCS oil and gas development would take place. The EIS discusses possible negative impacts from global climate change on the ecology of the arctic tundra and potential effects of changes in the permafrost depth. It also discusses effects of reductions of sea ice in relation to arctic marine plankton, marine mammals (particularly polar bears), fish, birds, and the implications for Native subsistence harvests. Possible effects on fish populations and commercial fishing resulting from changes in the marine food web are also discussed.

The EIS also discusses the possibility of adverse effects on oil- and gas-related infrastructure due to sea-level rise and potential increases in severe weather events attributed to global climate change. Engineering measures would have to be taken in some cases to prevent damage and further risks to the environment. A discussion of specific engineering measures, such as those that may be needed for pipelines that become submerged by a rising sea level, is beyond the scope of this analysis. Since any significant environmental changes would take place over a period of decades, we expect that there would be an adequate amount of time available for the implementation of engineering strategies to cope with adverse effects.

Concern: The Ocean Conservancy et al., stated that the EIS should quantify the greenhouse gas emissions generated by the combustion of the oil and gas produced and assess their effects on global warming. Environmental Defense noted that the draft EIS failed to evaluate the need to dispose of or sequester carbon dioxide (CO_2) in the ocean environment. A testifier at the Anchorage, Alaska, public hearing stated that the draft EIS analysis indicated that less offshore leasing would result in increased conservation and, hence, reduced greenhouse gas emissions.

Response: We have calculated the CO_2 emissions that would arise from the consumption of oil and gas that would be produced as a result of the proposed 5-year OCS leasing program. The emission rate was estimated to be 17.0- 34.5 million metric tons carbon equivalent (MMTCE) per year. This is about 1.1-2.3 percent of the total CO_2 emissions in the United States during the year 1998. For the cumulative case, the CO_2 emission rate was estimated to be 71.6-104.2 MMTCE/year, which is about 4.8-7.0 percent of the total nationwide CO_2 emissions, or 1.2-1.7 percent of thee current global CO_2 emissions from combustion. However, it should be realized that these figures cannot be used to predict future trends in the nationwide greenhouse gas emissions. The latter are driven by many different factors, including energy prices, energy mix, consumption patterns, and any government regulations or constraints. For this reason, the quantification of greenhouse gas emissions from consumption of OCS oil and gas is of rather limited value and, therefore, was not included in the EIS analysis.

As explained in Section 4.7.2 of the EIS, our model for analyzing energy alternatives showed that, if the proposed leasing program does not take place, almost 90 percent of the OCS oil that would have been produced would be replaced by imported oil or by increased onshore production. Most of the OCS gas would be replaced by increased onshore production and imported gas and by switching from gas to oil. Some conservation would be realized, which would have a positive effect on reducing greenhouse gases. However, some of the benefits from conservation would be offset by fuel switching since oil generates more CO_2 than gas does. The increase in onshore production and in imports would generally have a neutral effect on greenhouse gas emissions. Considering these factors, we have estimated that without the proposed OCS leasing program, the CO_2 emissions presented above would be reduced by less than 10 percent. One must also consider that any future strategies to reduce greenhouse gas emissions are likely to include the substitution of natural gas for oil and coal because the burning of gas results in considerably lower emissions on an energy-equivalent basis. Without an OCS leasing program, some of the potential benefits of natural gas may be foreclosed.

The sequestration of CO_2 emissions on the OCS would not be that feasible because the vast majority of the individual emission sources are quite small. Furthermore, offshore facilities have very limited space, making the installation of the additional equipment that would be needed for sequestration impractical. Any national strategy to control greenhouse gas emissions would certainly involve an emissions trading scheme, which would allow a variety of options for offsetting CO_2 emissions.

ISSUE 27. Impacts on protected areas.

Issue Was Raised By: State of Florida, of Environmental Protection (DEP), California, Office of the Governor, State of Alaska, Environmental Defense/Charter, Ocean Conservancy et. al., National Parks Conservation Association, Anchorage public hearings.

Concern: The State of California stated that the DEIS did not address the effect of California's Marine Life Protection Act, Offshore Rocks National Monument status, and recent developments in the designations of California Marine Protected Areas.

Response: This EIS is prepared to assist the Secretary of Interior in deciding whether to place lease sales on the 5-Year Program schedule in Alaska and Gulf of Mexico OCS planning areas. The status, recent developments, or effects of California protected areas will not have a bearing on such a decision.

Concern: The Florida DEP wrote that the DEIS did not describe any State-owned and managed lands in Florida which could be impacted by OCS oil and gas activities. In addition, the Governor of Alaska as well as several other commenters suggested that the "Areas of Special Concern" (section 4.2.3.9) should be expanded to include such areas as State designated areas (e.g., wildlife refuges and sanctuaries), the Katchemak Bay Critical Habitat Area and the coastline of the Arctic National Wildlife Refuge in Alaska.

Response: The listing of protected areas in the DEIS was meant to be a representative list of the major areas that could be affected in each region rather than a complete listing of all parks, landmarks, and refuges. At the program stage, the estimates of possible activity which might take place are necessarily broad in scope. Consequently, most discussions are also broad regarding the location of potential impacts. Therefore, this EIS does not include a full listing or site-specific analysis of all existing and proposed protected areas because of the lack of specific information pertaining to possible nearby future development. The NEPA analysis for specific sales will thoroughly analyze the potential effects of the proposed action on nearby protected areas. At that time, alternatives to the proposal and special mitigating measures may be developed to address concerns in relation to nearby parks, historic landmarks, or refuges.

Concern: The Florida DEP stated that the descriptions of the Rookery Bay National Estuarine Research Reserve and the Apalachicola NERR should be reversed.

Response: The EIS has been corrected.

Concern: The National Parks Conservation Association stated that all impacts to natural resources (e.g., water quality, wildlife, subsistence) in parks "are significant and must be avoided." They disagreed with the "negligible" and "minor to moderate" impact levels estimated for these parks in the draft EIS.

Response: The impacts on resources (e.g., water quality, subsistence) within the park boundaries are examined, as well as those outside the boundaries, in Chapter 4 of the EIS. We indicate where the parks are and provide general boundaries in Chapter 3 under "Areas of Special Concern" for the respective OCS regions. We also draw general conclusions of levels of impact (sections 4.3.2.10 and 4.3.3.9) using the impact levels defined in section 4.2 for individual resources whether inside or outside of the parks. We then indicate to the reader that certain resources are within these special areas of concern. It is our judgment that the analyses of potential impacts to parks, based on the scenarios described in section 4.3.1, support the conclusions in the EIS. Subsequent NEPA analyses for specific sale proposals will be based on more detailed scenarios and will provide estimates of potential impacts for particular parks and other special areas of concern.

ISSUE 28. Economic impacts and revenue sharing.

Issue Was Raised By: State of Louisiana, Department of Natural Resources; North Slope Borough (NSB), Mayor George N. Ahmaogak, Sr.; Alaska Eskimo Whaling Commission; Barrow, Alaska Public Hearing testimony.

Concern: Five commenters stated that regions bearing the risks of OCS development do not receive revenue sharing to help mitigate the potential impact from development. One suggested MMS should include damage insurance in its budget.

Response: This issue is addressed in Section 1.2.5.1. of this EIS. That section makes the point that the availability of revenue sharing "is not a material factor in the determination of the size, timing, and location of lease sales within this 5-year schedule; therefore, further analysis of these proposals is beyond the scope of this EIS."

However, the Oil Pollution Act of 1990 (P.L. 101-380) includes provisions requiring compensation for damages created by onshore and offshore oil spills. Levels of compensation specified in the legislation should prove to be adequate for physical, environmental, and social damages. Furthermore, the *Commerce, State, and Justice Fiscal Year 2001 Appropriations Act* created a Coastal Impact Assistance Program for which Congress appropriated $150 million for Fiscal Year 2001.

Concern: The NSB recommended that MMS clearly state in the EIS its support for revenue sharing, and the Mayor was critical of how 8(g) payments are distributed.

Response: MMS has supported the concept of revenue sharing. As noted above, Section 1.2.5.1. of the EIS discusses this issue. Further consideration of revenue sharing matters, such as how the States distribute 8(g) funds, is beyond the scope of the EIS.

ISSUE 29: Impacts on land use and infrastructure.

Issue Was Raised By: New Orleans, Louisiana, public hearing; Greater Lafourche Port Commission; U.S. Congressman Jeff Miller; Port Graham Council; Environmental Defense.

Concern: Richard Charter of Environmental Defense said that the draft EIS failed to fully disclose the implications of OCS activities on shoreline industrialization and land-use issues within the coastal zone.

Response: Land-use and infrastructure analysis for the 5-year program is a broad-level assessment. Subsequent steps and analyses will be developed for various lease sales in specific geographic locations. Currently, MMS has several research efforts ongoing that will aid in continued analysis of land-use and infrastructure impacts from OCS activities along the coastal zone. Applicable ongoing study efforts are as follows: "*Supply Logistics of OCS Oil and Gas Development in the Gulf of Mexico—Evaluation of Technological and Economic Parameters of Ports as Supply and Manufacturing Bases," "OCS-Related Infrastructure in the GOM," "Benefits and Burdens of Deepwater OCS Activities on Selected Communities and Local Public Institutions," "An Analysis of the Socioeconomic Effects of OCS Activities on Ports and Surrounding Areas in the Gulf of Mexico Region," and "A Socioeconomic Analysis of Port Expansion at Port Fourchon."*

Concern: A possible concern is the encroachment of onshore impacts related to offshore development on the Eglin Air Force Base Water Range, which is used for military training.

Response: This issue was not considered in the EIS because the area for Lease Sale 181 has been reduced to the point that it will not interfere with training exercises at Eglin Air force Base Water Range. Considering that the proposed action in the 5-year EIS is the same for the eastern Gulf as Lease Sale 181, we do not expect any interference. MMS is currently collecting baseline information throughout Florida by conducting county-level descriptions from a social and economic perspective in a study titled "*Effects on Local Human Communities from OCS Mineral Extraction in Frontier Areas.*" This information will be used if eastern Gulf of Mexico lease sales come to fruition.

Concern: Ted M. Falgout, the Executive Director of Greater Lafourche Port Commission, stated that the impacts to isolated areas in the Gulf of Mexico region, such as Port Fourchon, are higher than the "moderate" impact level indicated.

Response: MMS is aware of the substantial impacts that have occurred in a few focal point areas along the coast. The impact level may be somewhat higher in these specific locations. However, when considering several areas across the region and the differences between supply and manufacturing ports, the impact level is analyzed to be "moderate." Nonetheless, if we consider Port Fourchon, specifically, the impact could be "major." This change has been made in the EIS (Section 4.3.2.12). We have initiated several studies to better understand the profound and fast pace change resulting in impacts that are occurring. The studies listed above in this section are taking this into consideration. Especially the study, "*Supply Logistics of OCS Oil and Gas Development in the Gulf of Mexico—Evaluation of Technological and Economic Parameters of Ports as Supply and Manufacturing Bases."* This effort is attempting to work directly with port directors to help in developing a methodology to measure the flow of goods and services in and out of port areas to enable local community leaders to better plan and be proactive in area development.

Concern: During the New Orleans public hearing, Darryl Malek-Wiley of the New Orleans group of the Sierra Club stated that Section 3.1.3.2 describes the demand for infrastructure to be on the increase; however, there is no discussion of how this may effect coastal Louisiana.

Response: Section 3.1.3.2 describes the environment while Section 4.3.2.12 discusses the impacts from the proposed action.

ISSUE 30: Impacts on fisheries.

Issue Was Raised By: State of Alaska; Trustees for Alaska; Cook Inlet Keeper; Anchorage public hearing testimony.

Concern: The State of Alaska expressed concerned that the discussion of fisheries in the draft EIS implied that blocks offshore Yakutat within the Gulf of Alaska Planning Area were on the schedule. This was contrary to the decision document which did not include the Gulf of Alaska.

Response: As stated in Chapters 2 and 4 of the EIS, no sales in the Gulf of Alaska are included in the proposed program or any alternatives. A description of the environment was included for the Gulf of Alaska because crude oil from the North Slope and potentially from the Beaufort Sea would be transported by tanker from Valdez through the Gulf of Alaska to west coast ports.

Concern: The Trustees of Alaska and Cook Inlet Keeper stated that new information from the Exxon Valdez oil spill must be included in the final EIS describing the persistence of hydrocarbon-based pollutants in fish and other wildlife around the Exxon Valdez area. Multi-generation experiments with pink salmon conducted by the National Oceanic and Atmospheric Administration and the National Marine Fisheries Service in Auk Bay show chronic exposure of parent stocks to polyaromatic hydrocarbons (PAH's) from the Valdez spill, at levels of parts-per-billion or less, causing functional sterility.

Response: New information on long-term impacts to pink salmon from exposure to PAH's has been added to Section 4.3.3.6.2. Accidents (Sublethal and Chronic Effects).

ISSUE 31. Impacts on tourism and recreation.

Issue Was Raised By: State of Florida, Department of Environmental Protection (DEP); Pinellas County Board of County Commissioners; Ocean Conservancy et al.

Concern: The Florida DEP stated that the draft EIS does not address the safety concerns relative to statements that oil and gas structures experience over two million visits by fishermen per year.

Response: This concern has been raised in the past, and in areas such as southern California, a safety zone around each structure has been established. In the Gulf of Mexico, where tides and wave activity are less of a concern, it was determined that recreational fishing vessels around platforms do not merit analysis as a significant issue in the EIS.

Concern: The Pinellas County Board of Commissioners stated that it would be unacceptable if, as predicted in the draft EIS, moderate impacts occurred from oil spills contacting beaches in Pinellas County, Florida.

Response: We describe the level of potential impacts in the EIS assuming an oil spill occurs and contacts environmental resources. It is very unlikely that an oil spill from the proposed program would occur and contact Pinellas County beaches because no area within 280 miles of those beaches is being considered for leasing. Also, a moderate impact level means that if a resource is contacted with oil, it would recover completely if proper mitigation or remedial action is taken (Section 4.2.1). Inherent in the definition of moderate impact is the understanding that significant impacts to the local tourist economy will take place while the beach is oiled and during oil-spill removal.

Concern: The Ocean Conservancy et al., maintained that wilderness recreation, hunting, hiking, and river rafting in the Arctic National Wildlife Refuge (ANWR) were not adequately described in Section 4.3.3.13. and that the effects of development on these activities would be major.

Response: Wilderness recreation, hunting, hiking, and river rafting were explicitly recognized in Section 3.2.3.4.1. Because the North Slope and ANWR are huge, the wilderness experience will be degraded in only a small portion of the area. Most of the true wilderness will remain for those seeking such experiences. Because of the relatively small area that will lose its wilderness character, potential impacts on recreation and tourism are expected to range from minor to moderate.

ISSUE 32: Impacts on sociocultural systems.

Issue Was Raised By: Alaska Eskimo Whaling Commission (AEWC); Ocean Conservancy et al.; Wanda S. Ballentine; Susan M. Petersen; Barrow, Alaska, public hearing testimony; North Slope Borough (NSB).

Concern: The AEWC pointed out that a sentence was in error concerning the magnitude of dietary effects above other social and cultural effects.

Response: The statement concerning the magnitude of dietary effects has been revised in Section 3.2.3.6.

Concern: The AEWC claimed that the EIS ignored their concerns.

Response: The MMS has participated in government-to-government meetings with many communities and tribal leaders of the arctic region. In addition, Information Transfer Meetings have been conducted as well as specialized research-design workshops with members of the AEWC and the NSB to specifically address their concerns. In 2001, MMS initiated a study at the request of the AEWC and the NSB titled "*Quantitative Description of Potential Impacts of OCS Activities on Bowhead Whale Hunting and Subsistence Activities in the Beaufort Sea.*" This study will analyze, quantify, and draw conclusions about sociocultural effects and social change as a result of oil and gas development as well as modernization in general. The 5-year program EIS takes into account information we have gained, to date, from the AEWC, the NSB, and other Alaska communities.

Concern: A concern of the AEWC was that sociocultural systems and environmental justice were not adequately addressed in terms of process/assessment issues and possible mitigation.

Response: Modernization and industrialization specifically are dealt with in terms of social and cultural change. The sections on land use and infrastructure and sociocultural systems aid in explaining the process and assessment in terms of both infrastructure and cultural change

(Sections 4.3.3.11. and 4.3.3.14.). Ultimately a determination must be made under Executive Order 12898 as to whether the environmental and health effects assessed are disproportionately high/adverse. This determination was done (Section 4.3.3.15). It was determined that disproportionate high/adverse impacts could occur in the case of a large oil spill. It was also determined that new onshore infrastructure could also produce adverse health or environmental impacts if there are effects on subsistence foods and/or harvest patterns. It was also stated that mitigation would not eliminate disproportionately high adverse impacts; however it will reduce them.

The authors state the overall cumulative effects of OCS activities on all of arctic Alaska (as stated on page 4-295 of the draft EIS under Section 4.8.3.14 Sociocultural Systems), should be minor. However, when specific impacts are mentioned, such as an oil spill or infrastructure development without proper mitigation, the impact level increases to moderate or major.

Concern: A commenter stated that Section 4.3.3.14 of the draft EIS does not refer back to Section 3.2.3.5.1.

Response: The communities were described in Chapter 3 and referred to throughout the remainder of the document. Section 3.2.3.5 is referred to in the first paragraph of Section 4.3.3.14. Indeed, in the second paragraph on page 4-144 of the draft EIS, two of these NSB communities are mentioned specifically.

Concern: The AEWC claimed that the discussion of the differential in social change between the NSB and Northwest Arctic Borough (NWAB) (draft EIS page 4-146) undermines attempts throughout the document to argue that adverse effects of social change are due to "more general agents of change."

Response: The analysis attempts to draw attention to the combination of benefits and costs of oil and gas development. This particular discussion (Section 4.3.3.14) centers around the availability of monetary resources that were gained by the NSB and used to finance health care, infrastructure, education, subsidized housing, etc. These same monetary resources were not available for the NWAB at the same level through oil and gas activity. Therefore, more economic prosperity lead to community change initiated by the communities themselves through the revenues received. In other words, they spent their money on the things that they felt would most benefit the community. This is a part of the social and cultural change as discussed. When oil and gas development was initiated on the North Slope, monies were received, ANCSA (Alaska Natives Claims Settlement Act) was initiated, and change was quite rapid. However, through the 1990's, revenues have decreased; thus, the pace of change in relation to oil and gas revenues has also slowed. This is why the City of Barrow and the NSB have discussed with MMS the potential problems associated with decreasing revenues. In order to better understand this process, MMS will initiate a new study in 2002 titled "*North Slope Borough Economy: 1975 to Present*" to better quantify the pace of economic change.

Concern: The AEWC claimed that no parallels are drawn between the Exxon Valdez spill and sociocultural impacts to NSB communities.

Response: The first and second paragraphs on page 4-148 of the draft EIS draw parallels between the Exxon Valdez spill and sociocultural impacts and subsistence effects on the North Slope. This was done using the estimates given in the EIS for the oil-spill scenario. The section then discusses this in terms of effects on subsistence and suggests participation in an effective spill response plan.

Concern: A commenter stated that in the last full paragraph on page 4-147 of the draft EIS, it is not clear which areas of Alaska the authors are discussing.

Response: The authors are referring to sub-arctic regions such as the Cook Inlet as discussed directly preceding the paragraph in question. The impacts on sociocultural systems in proximity to oil and gas development are expected to be minor in this subregion, in part, because of their geographic location and ethnic diversity.

Concern: The AEWC pointed out that the authors do not identify specific mitigation that would enable them to draw any conclusions regarding impact levels.

Response: The sections on sociocultural systems are treated in an overall programmatic perspective and conclude with a best estimate of impacts. Indeed, the sections on sociocultural systems are written conservatively, assuming little mitigation is in place. Yet, it must be stated that mitigation at the lease-sale level can reduce negative impacts; however, these impacts will not be eliminated. Thus, the program EIS uses a conservative approach. At the lease-sale level, additional mitigation specific to the sale area will be developed, as appropriate, to lessen effects.

Concern: The AEWC claimed that the conclusion reached on page 4-295 of the draft EIS concerning the cumulative impacts on sociocultural systems contradicts other statements made in this section concerning impact levels.

Response: The impacts from cumulative activities vary throughout Alaska. The first sentence, in the conclusion, on page 4-295 of the draft EIS, which reaches a conclusion of minor, is considering sociocultural systems throughout Alaska as well as routine activities and oil spills. Thus, the incremental effect from the proposed action is determined to be minor overall. However, when considering cumulative effects in specific geographic areas, such as the North Slope, the impact level could be much higher, as stated in the EIS.

Concern: Ocean Conservancy et al., argued that impacts to subsistence resources have not been "minor" (in reference to page 4-149 of the draft EIS) and that the analysis is inadequate.

Response: Page 4-146 of the draft EIS discussed impacts on sociocultural systems (including subsistence) from the proposed action. Thus, it is assessing the impacts from the proposed action itself, not from past exploration or development. Because oil spills are unplanned and highly unpredictable, the impact levels are also applied within different categories, namely routine activities and accidents. We believe this approach provides an effective, adequate analysis of the potential impacts from the proposed program.

An extensive examination of subsistence was done in Sections 3.2.3.5.2, 3.2.3.5.3, and 3.2.3.5.4 in the description of the affected environment portion of the draft EIS. Analysis of the effects of the proposed action on subsistence and the cumulative effects are discussed in Chapter 4.

Concern: Ocean Conservancy et al., claimed that the assessment ignores public comment, and the fact that North Slope residents have to attend meetings just to voice their concern is a major impact.

Response: The sections on sociocultural systems use a great deal of public testimony and traditional knowledge. Native voice was heard and developed into the analysis of this section. Furthermore, page 4-151 of the draft EIS (Section 4.3.3.15) discusses the manifestation of fear and concern for culture and subsistence as a result of engaging in opposition towards offshore oil and gas development, in turn, leading to social change and impacts.

Concern: The NSB suggest that to say rural Alaska is dependent upon the State of Alaska for provision of services, especially for education, is terribly misleading (Section 4.3.3.14 Sociocultural Systems).

Response: We are making a general statement concerning rural Alaska overall and not the NSB in particular. A dependency relationship between the NSB and the State was not meant to be implied, when in fact, much of the monies from which State revenues are derived come from the taxation of the oil industry, in places such as Pruhdoe Bay. The statement has been revised in Section 4.3.3.14.

Concern: The NSB argues that "nondisturbance" agreements have not addressed mitigation with concern to noise and disturbance effects making whales "skittish" and dangerous to hunt. Therefore, disturbance effects have not been effectively mitigated as stated in Section 4.3.3.14 Sociocultural Systems.

Response: We concur with the NSB and have revised Section 4.3.3.14.

ISSUE 33: Impacts on subsistence.

Issue Was Raised By: Austin Ahmasuk; Barrow, Alaska, public hearing testimony; Port Graham Council.

Concern: Commenters claimed that the draft EIS mistakenly portrays the subsistence hunt as one that produces high frequency noises from outboard motor use in pursuit of the whale.

Response: Section 3.2.1.5 suggest that small fishing and whaling boats produce a frequency of around 300 hertz (Richardson et al., 1995). This section describes the acoustic environment in general and is not singling out subsistence hunting. See Issue 32 for further elaboration on subsistence resources and sociocultural systems.

ISSUE 34. Analyses of the no-action alternative and alternative energy are incomplete.

Issue Was Raised By: The North Slope Borough (NSB), Mayor George N. Ahmaogak, Sr.; American Petroleum Institute (API); Environmental Defense; Ocean Conservancy, et al; numerous private citizens; New Orleans, Louisiana, public hearing testimony; Anchorage, Alaska, public hearing testimony.

Concern: API stated that MMS used a flawed Market Simulation Model to estimate the amount and percentage of alternative energy sources in the no-action alternative.

Response: API has characterized MMS's Market Simulation Model as "flawed" because it deals with oil and gas markets separately instead of simultaneously. An earlier version of the model included a routine that synthesized the interactions between the oil and gas markets. In practice, this routine had little effect on the results of the analysis while it greatly complicated the construction, operation, and exposition of the model. Because the results are meant to give an approximate answer to the question of how markets might respond to a loss of OCS oil and gas, we decided that it was prudent to keep the model as simple and straightforward as possible rather than stretch for some academic measure of "perfection."

Concern: The Ocean Conservancy, et al., and numerous others maintained that America cannot drill its way to energy security and independence and the no action alternative should present a comprehensive view of energy efficiency and alternative renewable fuels.

Response: This concern represents a misunderstanding about the function of the no-action alternative and this EIS. The no-action alternative looks at the most-likely result of not pursuing the proposed action or other alternatives that Government could adopt for the 5-year program. The mix of the most-likely energy alternatives would not be imposed on the economy by Government but would result from actions of the free market system. The EIS examines the environmental impacts of those energy alternatives.

Concern: The Ocean Conservancy, et al., stated that the no-action alternative does not consider the risks of oil spills from existing leases in the Beaufort Sea.

Response: Oil spills from existing leases are considered throughout Section 4.8, the cumulative case.

Concern: The Ocean Conservancy, et al., pointed out that oil spills in the Pacific Region associated with the no-action alternative are more numerous than for the proposed action.

Response: In the draft EIS, oil spills for the no-action alternative were reported on a different basis than those for the proposed action. This inconsistency has been corrected in the final EIS.

Concern: The Ocean Conservancy, et al., noted that some Alaskan oil had been sent to East Asia and wants a detailed analysis of the potential for increased exports.

Response: These shipments are infrequent and of limited quantity. An EIS cannot analyze every unlikely future scenario, and a detailed analysis of the potential for increased East Asian imports is beyond the scope of this EIS. There is no evidence that future oil shipments to East Asia will constitute any sizeable percentage of Alaskan production.

Concern: The NSB and the Ocean Conservancy, et al., maintained that the draft EIS described the no action alternative as the only case where a boom and bust effect will occur.

Response: The draft EIS stated that an interruption in the normal development sequence that would occur in the event of no-action was characteristic of a boom and bust condition. This does not necessarily mean that a bust would ensue. Nevertheless, this statement is clarified in the final EIS.

Concern: The Ocean Conservancy, et al., argued that the assumption that basic economic decisions in the U.S. economy will continue to be made through the free-market system is too broad to support the estimate of oil imports under no-action.

Response: A complete description of the assumptions and models used to estimate the energy response to no-action can be found in *Energy Alternatives and the Environment*, (King, 2001) which was documented in the draft EIS and is documented in the final EIS. This document was prepared by MMS for the 5-year program analysis and is available upon request.

Concern: The Ocean Conservancy, et al., and others stated that the draft EIS inadequately analyzes the pros and cons of alternative fuels [sic], especially hydrogen fuel cells and wind power.

Response: Research we conducted on energy alternatives had not been completed at the time the draft EIS was prepared. The final EIS (Sections 4.7.3.1.1. and 4.7.3.2.1.) includes the results of our research with much more positive findings respecting fuel cells and wind power.

Concern: The Ocean Conservancy, et al., noted that recognition of the risk of large-scale nuclear contamination from a nuclear plant accident was not mentioned in the draft EIS.

Response: This omission from the draft EIS has been corrected in the final EIS (Section 4.7.3.2.1.).

6. PRINCIPAL PREPARERS

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Major portions of the EIS are taken from or based on:

> Continental Shelf Associates, Inc. and LGL Alaska Research Associates, Inc. 2001. Environmental Report for the Outer Continental Shelf Oil & Gas Leasing Program: 2002-2007. U.S. Department of the Interior, Minerals Management Service, Environmental Division, Herndon, VA. OCS Study MMS 2001-0030.

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The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Minerals Revenue Management** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.

20 Years of Service to America
MMS
Minerals Management Service
1982-2002