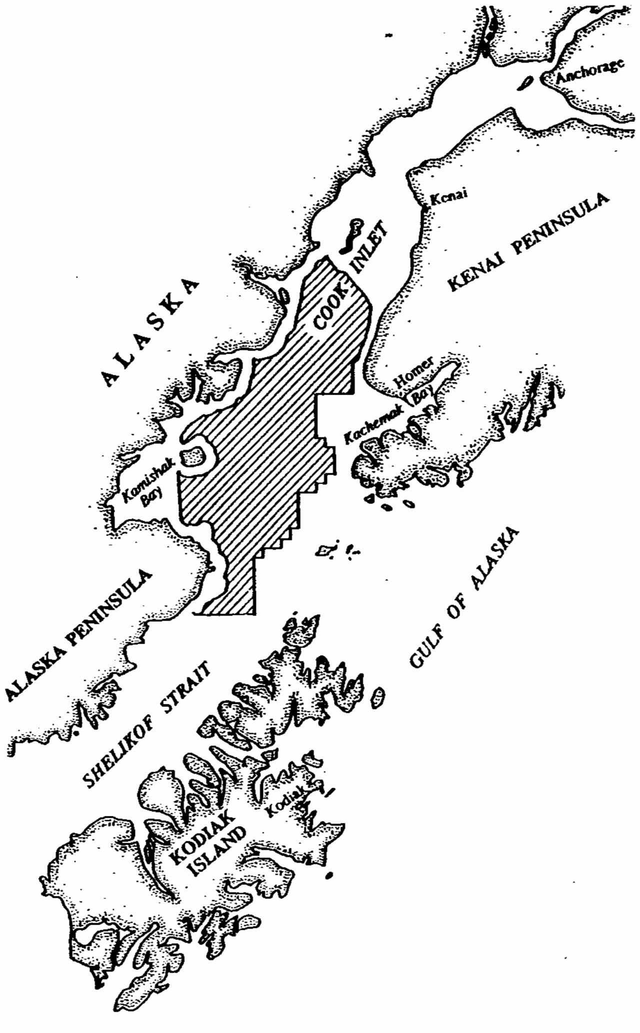
Alaska Outer Continental Shelf

OCS EIS/EA
MMS 95-0066

Cook Inlet Planning Area Oil and Gas Lease Sale 149

Final Environmental Impact Statement

Volume I



MMS
U.S. Department of the Interior
Minerals Management Service
Alaska OCS Region

This Environmental Impact Statement (EIS) is not intended, nor should it be used, as a local planning document by potentially affected communities. The exploration, development and production, and transportation scenarios described in this EIS represent best-estimate assumptions that serve as a basis for identifying characteristic activities and any resulting environmental effects. Several years will elapse before enough is known about potential local details of development to permit estimates suitable for local planning. These assumptions do not represent a Minerals Management Sservice recommendation, preference, or endorsement of any facility, site, or development plan. Local control of events may be exercised through planning, zoning, land ownership, and applicable State and local laws and regulations.

With reference to the extent of the Federal Government's jurisdiction of the offshore regions, the United States has not yet resolved some of its offshore boundaries with neighboring jurisdictions. For the purposes of the EIS, certain assumptions were made about the extent of areas believed subject to United States' jurisdiction. The offshore-boundary lines shown in the figures and graphics of this EIS are for purposes of illustration only; they do not necessarily reflect the position or views of the United States with respect to the location of international boundaries, convention lines, or the offshore boundaries between the United States and coastal states concerned. The United States expressly reserves it rights, and those of its nationals, in all areas in which the offshore-boundary dispute has not been resolved; and these illustrative lines are used without prejudice to such rights.

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U.S. Environmental Protection Agency
Region 10

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FINAL ENVIRONMENTAL IMPACT STATEMENT

Proposed Outer Continental Shelf
Oil and Gas Lease Sale
Cook Inlet
Sale 149

Summary Sheet

( ) Draft   **(X) Final**

U.S. Department of the Interior, Minerals Management Service, Alaska Outer Continental Shelf (OCS) Region, 949 East 36th Avenue, Anchorage, Alaska 99508-4302.

1. **Type of Action:** Proposed Oil and Gas Lease Sale 149, Cook Inlet.

(X) Administrative   ( ) Legislative

2. **Description of the Proposed Action (Alternative I):** The proposed action would offer 402 blocks (approximately 0.8 million hectares [ha], or 1.98 million acres) of the Cook Inlet Planning Area for leasing. These blocks are located in waters that are from about 5 to 40 kilometers (about 3-25 mi) offshore and generally from greater than 10 meters (m) to about 200 m (about 30-650 ft) deep. To examine the potential range of effects that might occur as a result of the lease sale, three cases—low, base, and high—are analyzed for Alternative I. The low-case analyses are based on no discovery or the discovery of a small quantity of oil, 0 to 24 million barrels (MMbbl), that is too low to be economically developed and produced. Thus, the low case represents the minimum amount of industry activity expected to occur if the quantity of oil discovered as a result of the lease sale is less than the amount required for economical recovery. If commercially recoverable oil resources are discovered and developed and produced as a result of Sale 149, MMS estimates this amount most likely would range from 100 to 300 MMbbl; this estimate is the basis for the base-case analyses. The high-case analyses are based on an estimate of 550 to 1,100 MMbbl.

Considerable uncertainty exists with respect to the volumes of undiscovered resources. As geologic information becomes available through drilling, the uncertainty and risk are reduced. To factor this uncertainty into the analysis, the resource estimates are presented as ranges of possible values over a range of likely prices (Appendix A).

Natural gas is determined to be not economic to produce in the Sale 149 area for the reasonably foreseeable future.

For Alternative I and the areal deferral alternatives, the maximum number of blocks that would be leased is 250.

3. **Environmental Effects:** Petroleum-related activities on all blocks offered pose some degree of pollution risk to the environment if leased, explored, and developed. The risk is related to adverse effects on the environment and other resource uses that may result from accidental or chronic oil spills and other operational activities. Socioeconomic effects from onshore development could have regional and local implications. Several alternatives and mitigating measures could be adopted (see Sec. II), which may reduce the type, occurrence, and extent of adverse effects associated with this proposal. In spite of mitigating measures, some effects from oil spills are considered unavoidable. For instance, if oil were discovered and produced, oil spills would be statistically probable, and there would be some disturbance to fishery and wildlife resources and associated subsistence, sport, and commercial uses; and some onshore development could occur in undeveloped areas.

4. **Alternatives to the Proposed Action:**

a. No Lease Sale (Alternative II): The no-sale alternative would remove the entire area of Alternative I from leasing.

b. **Delay the Sale (Alternative III)**: This alternative would delay the sale for up to a 2-year period.

c. **Wildlife Concentration Deferral Alternative (Alternative IV)**: Alternative IV would offer 350 blocks (about 0.7 million ha, or 1.73 million acres) for leasing. This alternative modifies the proposed lease sale by deleting 52 blocks (about 0.10 million ha, or 0.24 million acres) in areas located near Cassock and Duck Islands (Tuxedni Bay) and the Barren Islands. The amount of oil that might be discovered and developed and produced as a result of this alternative is estimated to range from 80 to 240 MMbbl.

d. **Coastal Fisheries Deferral Alternative (Alternative V)**: Alternative V would offer 248 blocks (about 0.54 million ha, or 1.33 million acres) for leasing. This alternative modifies the proposed lease sale by deleting 153 blocks (about 0.26 million ha, or 0.65 million acres) adjacent to the lower Cook Inlet coast from the proposed sale area. The amount of oil that might be discovered and developed and produced as a result of this alternative is estimated to range from 70 to 210 MMbbl.

e. **Pollock-Spawning Area Deferral Alternative (Alternative VI)**: Alternative VI would offer 360 blocks (about 0.72 million ha, or 1.79 million acres) for leasing. This alternative modifies the proposed lease sale by deleting 42 blocks (about 0.08 million ha, or 0.19 million acres) located in the northwestern part of Shelikof Strait from the proposed sale area. The amount of oil that might be discovered and developed and produced as a result of this alternative is estimated to range from 75 to 225 MMbbl.

f. **General Fisheries Deferral Alternative (Alternative VII)**: Alternative VII would offer 186 blocks (about 0.43 million ha, or 1.06 million acres) for leasing. This alternative modifies the proposed lease sale by deleting 217 blocks (about 0.37 million ha, or 0.92 million acres) adjacent to the lower Cook Inlet and northwestern Shelikof Strait coasts from the proposed sale area. The amount of oil that might be discovered as a result of this alternative is estimated to be too small (about 80 MMbbl) to be economically recovered; thus only exploration is expected.

g. **Northern Deferral Alterative (Alternative VIII)**: Alternative VIII would offer for lease 285 blocks (about 580,000 ha or 1.44 million acres) in that part of the Sale 149 area south of Anchor Point. The area removed by the deferral alternative consists of 117 whole or partial blocks (about 220,000 ha or 0.48 million acres), about 29 percent of the Alternative I area, located north of Anchor Point. The amount of oil that might be discovered and developed and produced as a result of this alternative is estimated to range from 70 to 210 MMbbl.

h. **Kennedy Entrance Deferral Alternative (Alternative IX)**: Alternative IX would offer for lease 385 blocks (about 760,000 ha or 1.88 million acres). The area removed by the deferral alternative consists of 17 blocks (about 40,000 ha or 0.10 million acres) in two areas adjacent to Kennedy Entrance. One of the areas is off the southwestern end of the Kenai Peninsula, and the other is west of the Barren Islands. The amount of oil that might be discovered and developed and produced as a result of this alternative is estimated to range from 100 to 300 MMbbl.

5. **Other Environmental Impact Statements, OCS Reports, Reference Papers, and Technical Papers**: This environmental impact statement (EIS) refers to numerous EIS's, OCS reports, reference papers, and technical papers previously prepared by the Alaska OCS Region. Applicable portions of these documents are referenced in the appropriate discussions throughout this EIS. Copies of referenced documents have been placed in a number of libraries throughout Alaska and the Department of the Interior Library in Washington, D.C. Single copies of these publications can be obtained from the Alaska OCS Region (when available) and the National Technical Information Service.

6. **Public Hearings**: Public hearings on the draft EIS were held in March 1995 in the following Alaska communities: Anchorage, March 3; Kenai, March 6; Homer, March 7; and Kodiak, March 8. The communities of Nanwalek, Port Graham, Seldovia, Ouzinkie, and Port Lions were invited to take part in a teleconference on March 3, but only Seldovia participated. Oral and written comments were received and are responded to in this final EIS.

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Proposed Cook Inlet Oil and Gas Lease Sale 149
Final Environmental Impact Statement

TABLE OF CONTENTS

VOLUME I

I. PURPOSE AND BACKGROUND OF THE PROPOSED ACTION

II. ALTERNATIVES INCLUDING THE PROPOSED ACTION

III. DESCRIPTION OF THE AFFECTED ENVIRONMENT

IV. ENVIRONMENTAL CONSEQUENCES

VOLUME I

V. REVIEW AND ANALYSIS OF COMMENTS RECEIVED

VI. CONSULTATION AND COORDINATION

LIST OF FIGURES, TABLES, AND GRAPHICS

Table No. **Title (follows the page number after the title)**

Graphic No. Title (Foldout graphics are found in an envelope inside the back cover)

SUMMARY OF THE ENVIRONMENTAL IMPACT STATEMENT FOR PROPOSED COOK INLET OIL AND GAS SALE 149

This environmental impact statement (EIS) discusses a proposed oil and gas lease sale in the Cook Inlet Planning Area, analyzes its potential effects on the environment, describes alternatives, presents major issues determined through the scoping process and staff analyses, and evaluates potential mitigating measures. Descriptions of the (1) leasing and scoping process are given in Section I, (2) alternatives and mitigating measures in Section II, and (3) description of the environment in Section III. The potential effects of the lease sale are analyzed in Section IV.

Alternative I, the proposed action, is based on offering for lease 402 blocks (approximately 0.8 million hectares—1.98 million acres) in lower Cook Inlet that range from about 5 to 50 kilometers (3 to 25 mi) offshore. Alternative II (No Lease Sale) would cancel the proposed lease sale tentatively scheduled for April 1996. Alternative II (Delay the Sale) would delay the proposed sale for 2 years. Alternatives IV, V, VI, VII, VIII, and IX would defer from leasing areas adjacent to the lower Cook Inlet and northwestern Shelikof Strait; the size of areas deferred ranges from about 5 to 45 percent of the area proposed for Alternative I. After a thorough review, the Secretary of the Interior will decide which alternative or combination of alternatives will be included in the Notice of Sale.

To examine the potential range of effects that might occur as a result of the lease sale, three cases—low, base, and high—are analyzed for Alternative I. The low-case analyses are based on no discovery or the discovery of a small quantity of oil, 0 to 24 million barrels (MMbbl), that is too low to be economically developed and produced. If commercially recoverable oil resources are discovered and developed and produced as a result of Lease Sale 149, Minerals Management Service (MMS) estimates the amount most likely would be represented by 100 to 300 MMbbl. This estimate is the basis for the base-case analysis. The high-case analyses are based on an estimate of a quantity of oil, 550 to 1,100 MMbbl, that represent the maximum resources if hydrocarbons are present in commercial quantities. For Alternatives IV, V, VI, VIII, and IX the amount of oil that might be discovered and developed and produced ranges from 70 to 300 MMbbl. For Alternative VII, the amount of oil estimated to be discovered is too low to be economically developed and produced.

The scenarios used to assess the potential effects that petroleum exploitation may have on the environment describe possible levels of activities and timing of events. For the base case, exploration and delineation wells are predicted to be drilled primarily from 1997 to 1998. Oil would be produced from two to five production platforms installed between 1999 and 2001; drilling for the production and service wells would occur between 2000 and 2002. Offshore pipelines may carry the produced oil from the production platforms to onshore facilities at Nikiski; pipeline laying would occur between 2001 and 2002. At Nikiski, Sale 149 oil would be commingled with crude oil from existing onshore and offshore production facilities in the Cook Inlet region. The oil may be (1) transported south through Kennedy Entrance to the west coast of the United States by 40,000- to 95,000-deadweight ton tankers and/or (2) refined and shipped to Anchorage by pipeline for use in Alaska.

For the base case, analysis indicates there would be an estimated 49 accidental oil spills of less than 1,000 barrels (bbl); the total volume of oil spilled is estimated to be 555 bbl (47 spills that average 5 bbl in size and 2 spills that average 160 bbl). There is about a 27-percent chance that a spill equal to or greater than 1,000 bbl would occur but, if it did, the size of the spill is estimated to be about 50,000 bbl. It is assumed no oil will be spilled during exploration activities. For Alternatives IV, V, VI, VIII, and IX the estimated number of small spills ranges from 34 to 49 and the volumes from 325 to 555 bbl. The probability of a spill equal to or greater than 1,000 bbl is estimated to range from 19 to 27 percent for Alternatives IV, V, VI, VIII, and IX; the assumed size of the spill is 50,000 bbl.

The possible environmental effects that could occur as a result of leasing are analyzed in Section IV of the EIS. The analyses supporting the conclusions assumes all laws and regulations are part of the proposed lease sale. The mitigating measures described in Section II.H of the EIS also are considered as part of the proposed action and would reduce some of the effects. (The purpose and effectiveness of the potential mitigating measures are discussed in Sec. II.H). Summaries and comparison of the possible effects of the alternatives and the cumulative case are presented in Section II.I.

This EIS is not intended, nor should it be used, as a local planning document by potentially affected communities. The facility locations and transportation scenarios described in this EIS represent assumptions that were made as a basis for identifying characteristic activities and any resulting environmental effects. These assumptions do not represent an MMS recommendation, preference, or endorsement of any facility, site, or development plan.

SECTION I

PURPOSE AND BACKGROUND OF THE PROPOSED ACTION

Section I—Table of Contents

I. PURPOSE AND BACKGROUND OF THE PROPOSED ACTION

I. PURPOSE AND BACKGROUND OF THE PROPOSED ACTION

Purpose: The purpose of the proposed action is to lease, explore, develop, and produce oil and gas resources on the OCS in the Cook Inlet Planning Area to meet national energy demands.

Background: The U.S. Department of the Interior (USDOI) is required by law to manage the Federal offshore natural gas and oil leasing program on the Outer Continental Shelf (OCS). These vital natural resources are to be developed prudently and in an environmentally sound manner. The Federal Government must, among other things, balance orderly resource development with protection of the human, marine, and coastal environments; ensure that the public receives a fair return for these resources; and preserve and maintain free enterprise competition.

In compliance with the Outer Continental Shelf Lands Act of 1953 (OCSLA), as amended (43 U.S.C. 1331 et seq.), the Secretary of the Interior submits a proposed 5-year oil and gas leasing schedule to the Congress, the Attorney General, and the governors of affected states. The Secretary annually reviews, revises as necessary, and maintains the natural gas and oil leasing program. Goals of the program include (1) the orderly development of OCS natural gas and oil resources in an environmentally acceptable manner, (2) the maintenance of an adequate supply of OCS production to help meet the Nation's energy needs, and (3) the reduction of dependency on foreign oil. The purpose of this proposed lease sale is to contribute to attaining those goals.

Current U.S. energy demands are met primarily by domestic and foreign fossil fuel. It has become increasingly apparent that our Nation must become less dependent on foreign imports and lessen our vulnerability to supply economics and supply interruptions.

A. **Leasing Process:** The OCSLA charges the Secretary of the Interior with administering mineral exploration and development on the U.S. OCS and with conserving its natural resources. The Secretary has delegated authority to carry out offshore mineral development functions to the Minerals Management Service (MMS). This program produces relevant information about potential effects of natural gas and oil activities on the environment (OCS Environmental Studies Program [ESP]) and on communities and regions of Alaska as a whole (Social and Economic Studies Program). The ESP also supports monitoring of potential postsale changes in environmental conditions to provide a basis for mitigating any unforeseen effects. For specific information on the MMS studies program, refer to Appendix E. The OCS oil and gas leasing program is implemented by 30 CFR 256. Lease supervision and regulation of offshore operations are implemented by 30 CFR 250. The following steps summarize the leasing process for the proposed sale.

1. **Leasing Schedule:** The OCSLA, as amended, requires that the Secretary prepare and maintain a 5-year OCS natural gas and oil leasing schedule and review the program annually to ensure that it is current. The present 5-year program announced by the USDOI in July 1992 (the OCS Natural Gas and Oil Resource Management Comprehensive Program 1992-1997 [CP]) (USDOI, MMS, 1992) consists of 18 proposed lease sales for the period 1992 through 1997. Six of these proposed lease sales are in planning areas offshore Alaska. Cook Inlet Sale 149 is tentatively scheduled to be held in early 1996. The OCS leasing program does not represent a decision to lease in a particular area. Instead, it is representative only of the Department's intent to consider leasing in identified areas, and to proceed with the offering of such areas only if it should be determined that leasing and development would be environmentally acceptable and technically feasible.

An Area Evaluation and Decision Process (AEDP) has been implemented for this sale under the present 5-year CP. The AEDP provides a framework for the activities that precede the decision of whether and under what conditions to hold an individual OCS natural gas and oil lease sale. These activities include coordination and consultation, information acquisition, environmental studies, resource evaluations, decisions, and review and comment procedures under the OCSLA and the National Environmental Policy Act of 1969 (NEPA). This process includes an Information Base Review (IBR), Request for Interest and Comments (RFIC), Call for Information and Nominations (Call), Notice of Intent (NOI) to Prepare an Environmental Impact Statement (EIS), and scoping and other coordination meetings.

2. **Information Base Review:** The goal of this process is to document the acquisition of environmental, geologic, and economic information to be used in OCS management and decisionmaking. If it is determined that sufficient information exists to proceed with the prelease process, the MMS would implement the

next step, the RFIC. If a determination is made that additional studies are needed before the next step can proceed, studies are requested. An IBR for Sale 149 began on June 17, 1991. Letters requesting information and other data were mailed to various groups, including Federal and State agencies, industry, environmental groups, consulting firms, Native organizations, and fishermen's organizations. An Information Transfer Meeting held January 28-30, 1992, in Anchorage provided an additional opportunity for the public to comment on information that could enhance the EIS analysis. The information received focused mostly on Cook Inlet and, in general, public responses were somewhat negative. However, no immediate scientific needs were identified that would warrant not proceeding with the EIS.

3. <u>Request for Interest and Comments</u>: This step obtains information to assist MMS in determining the level of industry and public interest. This information, along with the results of the IBR, was considered in deciding whether to proceed with the Call and NOI.

An RFIC for Sale 149 was published on August 29, 1991. The area identified as available for consideration for leasing was 254 blocks covering 1.2 million acres, as included in the draft comprehensive program for 1992-1997, which was then being prepared. Seventeen comments were received. Five responses were from oil companies urging that preparations continue for possible leasing in the area. Comments from the State of Alaska, two Federal agencies, and local and environmental groups expressed concern about potential effects to a variety of resources. A Notice of Request for Comments on New Alternatives to the Proposed 5-year CP was announced on December 19, 1991, and resulted in an expansion of the area of offering for Sale 149 from 254 blocks and 1.2 million acres to 761 blocks and 3.7 million acres. The 5-year-program decision included a limit to the number of leases that can be issued to no more than 250.

4. <u>Call for Information and Nominations and Notice of Intent to Prepare an EIS</u>: A Call for Information and Nominations and Notice of Intent to Prepare an EIS are notices published in the *Federal Register* inviting the oil industry, governmental agencies, environmental groups, and the general public to comment on areas of interest or special concern in the proposed lease-sale area. The Call/NOI for proposed Cook Inlet Sale 149 was published in the *Federal Register* on February 7, 1992 (57 *FR* 4800).

In response to the Call, 15 comments and/or nominations were received: 3 from the oil and gas industry, 1 from the State of Alaska, 3 from Federal Agencies, 3 from environmental entities, 1 from a fishing group, 3 from area and local representatives, and 1 from an individual. The nominations received indicated interest in all 761 blocks.

The comments received on the NOI are discussed in Section I.D, Results of the Scoping Process.

5. <u>Scoping</u>: The NOI, published in the same document as the Call (Sec. I.A.3), serves to announce the scoping process that will be followed for the EIS. The Council on Environmental Quality defines scoping as "an early and open process for determining the scope of issues to be addressed in an EIS and for identifying the significant issues related to a proposed action" (40 CFR 1501.7). It is a means for early identification of important issues deserving of study in an EIS. The intent of scoping is to avoid overlooking important issues that should be analyzed in the EIS. Comments are invited from any interested persons, including affected Federal, State, and local governmental agencies; any affected Native groups; conservation groups; and private industry. Information obtained from the meetings and the Call is considered part of scoping.

Based on information gained through the scoping process—which includes staff evaluation and input—major issues, alternatives to the proposed action, and measures that could mitigate the effects of the proposed action are identified for analysis in the EIS.

For proposed Cook Inlet Sale 149, MMS held scoping meetings in Kodiak, Port Lions, Larsen Bay, Chignik, Homer, Seldovia, Nanwalek, Port Graham, Soldotna, and Anchorage. In addition, dialogue meetings were held in the communities of Port Graham, Karluk, Nanwalek, Seldovia, Ouzinkie, Homer, and Kodiak.

6. <u>Proposed Action and Alternatives Memorandum (PAAM)</u>: The purpose of this step is to determine whether to proceed with, delay, or cancel the further development and analysis of a leasing proposal. If the decision is to proceed, MMS determines and announces the scope of that review and analysis (alternatives, mitigation, and issues to be analyzed). The PAAM documents the consultation process and the information used to ensure an informed decision on the identification of the proposed action to be analyzed in the draft EIS. The

PAAM reports relevant conclusions of the IBR; summarizes and analyzes responses to the Call; presents and summarizes the scoping process and the comments and concerns raised in that process; and discusses and recommends alternatives, mitigating measures, and issues to be analyzed in the draft EIS. The PAAM provides the background information necessary to make an informed decision regarding the leasing proposal.

7. **Area Identification (Area ID)**: The Regional Director, MMS, uses the PAAM to make a recommendation to headquarters as to whether, when, and how to proceed with Area ID. The Area ID is the area of study for the EIS. A final PAAM is prepared in headquarters and the MMS Director forwards recommendation on the Area ID and scope of the EIS to the Secretary/Assistant Secretary, Lands and Minerals, for approval. The Secretary/Assistant Secretary will approve or disapprove the Director's recommendation. If the decision is to proceed with preparation of the draft EIS, an Area ID announcement is made. The Area ID announcement for Sale 149 was made on August 13, 1992, and included all 761 blocks covering 3.7 million acres. However, on January 27, 1994, the USDOI announced its decision to defer approximately 1.7 million acres of the Shelikof Strait area from the Sale 149 proposal. A small portion of the northwestern Shelikof Strait remains in the area selected for further analysis in this EIS. The revised Sale 149 area consists of 402 blocks covering approximately 2 million acres (Fig. II.A.1).

8. **Preparation of Draft Environmental Impact Statement (DEIS)**: As required by Section 102(2)(C) of the NEPA, an EIS must be prepared for any major Federal activity having the potential of significantly affecting the quality of the human, marine, and coastal environments. Offshore leasing is considered a major Federal activity for which an EIS must be prepared.

The DEIS describes the proposed lease sale and the natural and human environments, presents an analysis of potential adverse effects on these environments, describes potential mitigating measures to reduce the adverse effects of offshore leasing and development, describes alternatives to the proposal, and presents a record of consultation and coordination with others during EIS preparation.

The document is filed with the U.S. Environmental Protection Agency (USEPA), and its availability is announced in the *Federal Register*. Any interested party may request a copy of the DEIS by contacting the MMS office listed in the *Federal Register*. The public has 90 days to review and comment on the DEIS.

Concurrent with the release of the DEIS, a copy of a proposed notice of sale is furnished to the Governor of Alaska, pursuant to Section 19 of the OCSLA, so that he and any affected local governments may comment on the size, timing, and location of the proposed sale. Comments must reach the Secretary within 90 days after the proposed notice is released.

9. **Endangered Species Consultation**: Pursuant to Section 7 of the Endangered Species Act of 1973 (ESA), as amended, MMS consults with the Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS), as appropriate, to determine whether a species that is listed as endangered or threatened may be jeopardized by the proposed action. Both formal and informal consultations are conducted on the potential effects of OCS leasing and subsequent activities on endangered and threatened species in Cook Inlet. In accordance with the ESA Section 7 and regulations governing interagency cooperation, the MMS notified the NMFS and FWS on April 6, 1992, of the endangered and threatened species that would be included in a biological evaluation for Section 7 consultation. The NMFS responded on April 15, 1992, and the FWS responded on May 11, 1992, confirming that the species to be evaluated in the EIS were correctly specified (see Appendix I).

Requests for formal consultation on leasing and any exploration that may occur as a result of proposed Sale 149 were transmitted to the FWS and NMFS on March 25 and 26, 1993, respectively. A Biological Evaluation analyzing potential effects of this action accompanied these requests. A Biological Opinion for the Sale 149 area was received from NMFS on October 15, 1993; the FWS Biological Opinion is under revision based on additional information and consultation.

10. **Public Hearings**: Public hearings are held after release of the DEIS, and specific dates and locations for public hearings are announced in the *Federal Register*. Public hearings on the draft EIS were held in March 1995 in the following Alaska communities: Anchorage, March 3; Kenai, March 6; Homer, March 7; and Kodiak, March 8. The communities of Nanwlek, Port Graham, Seldovia, Ouzinkie, and Port Lions were invited

to take part in a teleconference on March 3, but only Seldovia participated. Oral and written comments were received and are responded to in this final EIS.

11. **Recommendation and Report:** A recommendation to proceed with preparation of the FEIS was prepared based on written and oral comments received on the DEIS and the proposed Notice of Sale. Recommendations included new alternatives and new and modified mitigating measures. These changes are noted in Section I.G. of this FEIS.

12. **Preparation of the Final Environmental Impact Statement:** Comments on the DEIS, both written and oral, have been printed in this FEIS along with responses. Major changes in the FEIS that are a result of this public review process are noted in Section I.G.

13. **Consistency Determination:** As required by the Coastal Zone Act Reauthorization Amendments of 1990, a Consistency Determination will be released once the FEIS is made available. This document is prepared to determine whether the proposed sale is consistent with the enforceable policies of the State's approved Coastal Management Program to the maximum extent practicable.

14. **Decision Document:** A decision document is prepared that includes a discussion of significant information connected with the proposed lease sale. The decision document provides relevant environmental, economic, social, and technological information to assist the Secretary in making a decision on whether to proceed with preparation of a final notice and, if so, what terms and conditions should be applied to the sale and leases. This document is based in part on the FEIS; comments from the Governor of Alaska on the proposed notice regarding size, timing, location, terms, and conditions of the sale; comments received on the FEIS; a determination of consistency with coastal management plans; and biological opinions from NMFS and FWS regarding the effect of the proposed action on endangered or threatened species.

15. **Decision and Final Notice of Sale:** The entire prelease process culminates in a final decision by the Secretary/Assistant Secretary on whether to hold a lease sale and, if so, its size, terms, and conditions. The Secretary/ Assistant Secretary of the Interior has the option of deferring from the sale area any or all of the area analyzed in the EIS or areas proposed for deletion after consultation with the Governor of Alaska, pursuant to Section 19 of OCSLA, as amended. The final notice of sale must be published in the *Federal Register* at least 30 days before the sale date. It may differ from the proposed notice depending on the Secretary's final decisions, i.e., size of lease sale, bidding systems, and mitigating measures.

The major analytic, decision, legal, and policy documents comprise the Sale 149 record of decision as required by Council on Environmental Quality regulations implementing NEPA. Of particular relevance are the decision documents at the Area Identification stage, the EIS, the decision documents for the proposed and final Notices of Sale, the consistency determination, and the sale-related correspondence with Governors.

16. **Lease Sale:** The Cook Inlet Sale 149 is tentatively scheduled to be held in mid-1996. Sealed bids for individual blocks and bidding units (those listed in the final notice) are opened and publicly announced at the time and place of the sale. The MMS assesses the adequacy of the bids, and the Department of Justice—in consultation with the Federal Trade Commission—may review them for compliance with antitrust laws. If bids are determined to be acceptable, leases may be awarded to the highest bidders. However, the Secretary reserves the right to withdraw any blocks from consideration prior to written acceptance of a bid and the right to accept or reject bids, generally within 90 days of the lease sale.

17. **Lease Operations:** After leases are awarded, the MMS's Field Operations Office is responsible for approving, supervising, and regulating operations conducted on the lease. Prior to any exploration activities on a lease, except preliminary activities, a lessee must submit an exploration plan, an Oil-Spill-Contingency Plan, and an Application for Permit to Drill to MMS for approval. The Office of Ocean and Coastal Resource Management, FWS, NMFS, USEPA, National Park Service (NPS), U.S. Army Corps of Engineers, U.S. Coast Guard, the State of Alaska, and the public are provided an opportunity to comment on the exploration plan. The exploration plan must be approved or disapproved within 30 days, subject to the State of Alaska's concurrence or presumed concurrence with the lessee's coastal zone consistency certification (pursuant to the Federal Coastal Zone Management Act). The MMS's environmental studies program is designed (MMS' legal mandate) to monitor

changes in human, marine, and coastal environments during and after oil exploration and development and is authorized in Section 20(b) of the OCSLA:

> Subsequent to the leasing and development of any area or region, the Secretary shall conduct such additional studies to establish environmental information as he deems necessary and shall monitor the human, marine, and coastal environments of such area or region in a manner designed to provide time-series and data trend information which can be used for comparison with any previously collected data for the purpose of identifying any significant changes in the quality and productivity of such environments, for establishing trends in the areas studied and monitored, and for designing experiments to identify the causes of such changes.

B. Leasing and Drilling History:

1. **Previous Lease Sales:** Two lease sales and one reoffering sale have been held in the Cook Inlet Planning Area. Sales CI and 60 were held in October 1977 and September 1981, respectively, and Reoffering Sale RS-2 was held in August 1982. These sales resulted in the issuance of 100 leases, all of which have been relinquished or have expired. Sale 88, originally scheduled for December 1984, was postponed indefinitely on February 20, 1985, and finally canceled in May 1986 for lack of industry interest. On May 17, 1989, the Department announced a decision to delay the next sale (Sale 114) to allow more time to assess the consequences of the *Exxon Valdez* oil spill that occurred in Prince William Sound. Sale 149 in part replaced Sale 114 when the new 5-year offshore leasing program was approved by the Secretary.

2. **Drilling:** One Deep Stratigraphic Test well and 13 exploratory wells have been drilled in the area, with no commercial discovery of oil or gas. All wells were plugged and abandoned.

C. Legal Mandates, Authorities, and Federal Regulatory Responsibilities:

The OCS Report, MMS 86-0003, *Legal Mandates and Federal Regulatory Responsibilities* (Rathbun, 1986), incorporated herein by reference, describes legal mandates and authorities for offshore leasing and outlines Federal regulatory responsibilities. This report contains, among other things, summaries of the OCSLA, as amended, and related statutes, and a summary of the requirements for exploration and development and production activities. Also included is a discussion of significant litigation affecting OCS leasing policy. This report is being updated. Many of the laws and regulatory programs addressed in this report have been amended and updated to further address safety and environmental protection during oil and gas operations. Included in OCS Report MMS 86-0003 are the OCS orders that have subsequently been updated and placed in the consolidated operating regulations found in 30 CFR 250.

The Oil Pollution Act (OPA) of 1990 (33 U.S.C. 2701, et seq.) is one of the significant new laws that will be addressed in the next updated edition of this report. The OPA expands on the existing Clean Water Act (CWA) and adds new provisions on oil-spill prevention, increases penalties for oil spills, and strengthens oil-spill-response capabilities. The act also establishes new oil-spill-research programs and provides special protection for selected geographic areas.

The MMS, Alaska OCS Region Reference Paper No. 83-1, *Federal and State Coastal Management Programs* (McCrea, 1983), incorporated herein by reference, describes the coastal management legislation and programs of the Federal Government and the State of Alaska. This paper highlights sections particularly pertinent to offshore oil and gas development and briefly describes some of the effects of the Alaska Native Claims Settlement Act and the National Interest Lands Conservation Act on coastal management.

Pursuant to the 1984 Memorandum of Understanding between the EPA and the USDOI concerning the coordination of National Pollution Discharge Elimination system (NPDES) permit issuance with the OCS oil and gas lease program, the MMS Alaska OCS Region and the USEPA Region 10 entered into a Cooperating Agency Agreement to prepare EIS's for oil and gas exploration and development and production activities on the Alaska OCS (Appendix K). Section 402 of the CWA authorizes the USEPA to issue NPDES permits to regulate discharges to waters of the United States, including the territorial seas, contiguous zone, and oceans. The NPDES permits for OCS oil and gas facilities many contain effluent limitations developed pursuant to sections of the CWA, including sections 301, 302, 306, 307, and 403. With the offshore subcategory under the CWA, the USEPA may have NEPA responsibilities for permits issued for new sources (Sec. 306 of the CWA), which overlaps with those of MMS. The EPA's primary role in the Cooperating Agency Agreement is to provide expertise in those fields specifically under its mandate.

D. **Results of the Scoping Process**: Scoping for the Cook Inlet Sale 149 EIS consisted of the IBR process, reviewing the comments received on the RFIC, input provided in response to the *Federal Register* notice on the proposed expanded area for inclusion in the proposed final 5-year CP, the Call, written and verbal comments submitted at the scoping meetings, the reevaluation of the issues raised and analyzed in the EIS's for previous Cook Inlet lease sales (Sales CI, 60, and 88), and staff input.

Scoping comments for the proposed lease sale were requested from the public through newspaper and radio advertisements, mailings, telephone contacts, and public meetings throughout the Cook Inlet area. In addition, letters were sent to (1) mayors of Kodiak, Port Lions, Larsen Bay, Chignik, Homer, Seldovia, Soldotna, Kenai, Kenai Peninsula Borough, and Kodiak Island Borough; (2) Village Chiefs in Nanwalek (English Bay) and Port Graham; and (3) Native associations in Kodiak, Dillingham, Anchorage, and Seldovia. Telephone calls were made to government, public, and private individuals including NPS, NMFS, FWS, State of Alaska, Department of Fish and Game (ADF&G), University of Alaska, Native associations and corporations, Tribal and Indian Reorganization Act Councils, tour and charter operators, fishermen's groups and aquaculture associations, city and borough government officials, and environmental groups. Scoping meetings were held in the villages of Port Lions, Larsen Bay, Nanwalek, Port Graham, Chignik, and Seldovia and in the cities of Homer, Soldotna, Kodiak, and Anchorage. The Scoping Report was published on August 17, 1992; over 100 copies were distributed.

1. **Major Issues Considered in the EIS:**

a. **Significant Issues**: The following environmental issues are a summary of all previous input and are identified for analysis in the EIS, because significant environmental effects may be involved. These environmental issues are related to important resources, activities, systems, or programs that could be affected by petroleum exploration, development and production, and transportation activities associated with sale-specific alternatives. The cumulative effects of present and future major activities on each of these resources also will be analyzed. These issues include:

Effects on Water Quality from

- oil spills
- discharge and disposal of drilling muds and cuttings, formation waters, and other hazardous material
- construction activities, including dredging activities
- cumulative additions to the waters of Cook Inlet

Effects on Air Quality from

- discharges of combustion gases and particulates into the atmosphere
- gas blowouts, evaporation and burning of spilled oil
- refining Alaskan crude oil in the contiguous 48 states

Effects on Lower Trophic-Level Organisms from

- oil spills
- discharge and disposal of drilling muds and cuttings, formation waters, and other hazardous material
- construction activities that affect the water column and seafloor biota

Effects on Fisheries Resources from

- oil spills
- discharge and disposal of drilling muds and cuttings and formation waters
- seismic activities
- construction activities as related to habitat disturbance and alteration

Effects on Marine and Coastal Birds from

- oil spills
- noise and other disturbances (terrestrial, marine, and air traffic)
- habitat loss and alteration

Effects on Nonendangered Marine Mammals (Pinnipeds, Cetaceans, and the Sea Otter) from

- oil spills
- noise and other disturbances (marine and seismic activities and marine and aircraft traffic)
- habitat loss and alteration

Effects on Endangered and Threatened Species from

- oil spills
- noise and other disturbances (seismic activities, marine and aircraft traffic, offshore-drilling operations, and dredging)
- habitat loss and alteration

Effects on Terrestrial Mammals and Habitats from

- oil spills (including tainting)
- construction activities
- land-vehicular and aircraft traffic along roads and onshore pipelines
- habitat loss and alteration

Effects on the Local Economy from

- revenues from oil activities
- increases in employment and population
- gains and losses from oil spills and cleanup events, including commercial-fishing and subsistence harvests at the community level

Effects on Commercial Fishing from

- oil spills
- reduced size of fishing areas
- gear conflicts
- status of threatened and endangered species

Effects on Subsistence-Harvest Patterns from

- oil spills
- industrial disturbance, including noise
- construction activities
- reduced access to resources
- changes in subsistence practices related to oil and gas activities
- increased population and industrial employment

Effects on Sociocultural Systems from

- changes in social organization
- changes in traditions and cultural values
- changes in population and employment
- changes to subsistence harvests, uses, and needs
- increased stress on sociocultural systems

Effects on Archaeological and Cultural Resources from

- onshore activities associated with offshore oil-spill cleanup
- loss and disturbance of archaeological resource sites

Effects on National Parks and Wildlife Refuges and Recreational Areas from

- oil spills
- increased population and industrial employment growth
- changes in aesthetic characteristics of the landscape

Effects on Coastal Zone Management Programs from

- potential conflicts with Coastal Zone Management and State land use

Cumulative Effects on all Resource Categories from

- transporting oil from the sale area
- this sale in combination with major projects that are undergoing planning and have approved construction permits

Effects from Earthquakes and Tsunamis

- potential conflicts of OCS activities with areas of active, naturally occurring seismic activity
- damage or destruction of facilities leading to adverse effects on natural resources and the environment

Oil-Spill-Containment and -Cleanup-Capability Issues

- oil-spill prevention
- oil-spill-contingency plan requirements
- improving oil-spill-cleanup technology in rough seas
- local capability to respond to spill incidents
- response strategies, including the use of dispersants and in situ burning
- response and coordination responsibilities
- availability and deployment of cleanup equipment

Offshore Technology Issues

- adequacy of the best available and safest technology to be used in the sale area

Alternative-Energy Sources and Energy-Policy Issues

- the EIS should contain a thorough alternative-energy analysis
- the effects of fossil fuels from this lease sale on global warming
- conservation of energy should be evaluated as an alternative to the lease sale
- independent advice should be sought to consider the value of alternative-energy sources to offset current uses of fossil fuels (this comment was received but is not applicable to the EIS)

Adequacy of Data and Studies

- lack of access to the *Exxon Valdez* oil-spill research and information
- lack of *Exxon Valdez* studies to describe current baseline information for the call area (data now released to public)
- lack of information on baseline data on biological resources, physical science, socioeconomic conditions, and water-quality studies

b. **Cumulative Effects**: The cumulative effects of past, present, and future major activities on each of the resources, activities, systems, or programs that were identified as significant issues in this section will be analyzed. Major activities include those projects that presently are developed or under construction and past OCS oil and gas lease sales in the Cook Inlet/ Shelikof Strait Planning Area (see Sec. IV.A.7 of this EIS).

Future major activities to be analyzed in the cumulative case and oil-spill-risk analysis for Sale 149 will be limited to: (1) petroleum-development and -production projects and transportation systems with estimated resources; (2) major construction projects with approved construction permits or other indications of coming to fruition; and (3) other major natural resource-related projects. Future activities that do not meet these criteria will be mentioned and described, if possible, if they affect the resources, systems, programs, or activities that have been identified as significant issues.

c. **Issues Considered but Not Warranting Detailed Analysis in the EIS**: The following issues were raised during the scoping process but will not be analyzed or will not be separately considered for the reasons indicated:

(1) **Authority to Propose a Lease Sale**: Chickaloon Village Indian people claimed during the Homer and Anchorage scoping meetings that MMS had no authority to propose a lease sale in the Cook Inlet area, because MMS was trespassing on lands to which the people of the Chickaloon Village claimed ownership and sovereignty, having never relinquished their rights to such lands. This issue is not considered in this EIS because it is not an environmental issue; it is an allegation that must be resolved by other forums, if at all.

(2) **Cleanup of Oil-Field-Waste Sites on the Kenai Peninsula**: The Public Awareness Committee for the Environment recommended strongly at the Homer and Anchorage scoping meetings that the Federal Government must become actively involved in cleaning up oil-field-waste sites on the Kenai Peninsula. The OCS activities from this proposed sale (or from past Cook Inlet OCS sales) have not contributed materials to any onshore disposal site. This topic is beyond the scope of this EIS.

(3) **The EIS Must Take a Global Perspective in its Analysis**: Testimony was presented in Homer and Anchorage that the EIS must take a global perspective on the environmental crimes, global warming, human-rights abuses, deforestation policies, and other actions of multinational oil-industry corporations that are being committed worldwide. This issue is not considered significant for this EIS, because this is a programmatic issue that was addressed in the OCS Natural Gas and Oil Resource Management Comprehensive Program (CP), 1992-1997, EIS. It already has been addressed in the "No Action" alternative and "Global Climate Change" sections of the CP EIS, which is summarized in this EIS and incorporated by reference.

(4) **Effects on Land Use**: The land use section of the EIS has been scoped out based on the fact that the issue of land use has generated little public interest apart from concerns regarding the potential siting of petroleum-related facilities and potential effects on national parks and wildlife refuges located within the area of Call. Facility-siting issues are not covered in the discussion of the scenario and are not be issues for effects analysis. Rather than being titled as a land use issue, potential effects on national parks and wildlife refuges are covered in the section on national parks and refuges and recreational areas.

2. **Alternatives:**

a. **Alternatives Suggested During the Scoping Process**: Several alternatives, such as delaying or canceling the sale, other than offering the entire area for leasing (Alternative I, the Proposal, Fig. II.A.1), were suggested during the scoping process for Sale 149. The following additional alternatives were developed by MMS in response to suggestions. (Also, several alternatives were suggested in the response to comments on the draft EIS for Sale 149 and these are described in Sec. V.A.2.a)

(1) **Alternative IV, Wildlife Concentration Deferral Alternative**: This alternative would offer for leasing all the area described for Alternative I except for areas located near Chisik and Duck Islands (Tuxedni Bay) and the Barren Islands (Fig. II.D.1). The areas removed by the deferral alternative consist of 52 whole and partial blocks (about 98,000 hectares [ha] or 241,000 acres), about 12 percent of the Alternative I area. Chisik and Duck Islands are part of the Alaska Maritime National Wildlife Refuge and constitute the largest

seabird colony in Cook Inlet; the FWS recommended deleting the Chisik/Duck Island area from the proposed sale area. The FWS also recommended establishing a buffer zone around the Barren Islands.

Sugarloaf Island in the Barren Islands group is the site of the second largest Steller sea lion rookery in Alaska (2,000+ pups in 1989). This species is classified as threatened under the ESA. Although adults are insulated by a layer of fat and are protected from oil-induced hypothermia, young pups have less insulation. Also, pups are likely to be more sensitive to the effects of oil on their eyes, nose, and mouth membranes. Oil contact could cause inflammation of these areas as well as problems with nursing, vision, and recognition between female-pup pairs. Local populations of Pacific harbor seals, currently a declining species in Alaska, and sea otters could be adversely affected by spilled oil contacting the Barren Islands. Also, the Barren Islands lie within the migration route for the gray whale and zone of probable occurrence of this and several other species of whales.

Deferral of blocks near the above areas could provide some geographic (spatial) protection for intensively used nearshore marine bird-foraging, -staging, -migration, and -overwintering areas. In addition, most seabirds forage in the vicinity of their colonies during the breeding season; these birds (particularly the alcidae, including murres and puffins) spend a great deal of time at the water's surface and so are extremely vulnerable to oil spills. Seabirds rely on the fish and invertebrates found in the waters surrounding their colonies for food, especially during the critical chick-rearing period. The full range of effects are addressed in this EIS.

(2) **Alternative V, Coastal Fisheries Deferral Alternative:** This alternative would offer for leasing only those blocks in the central part of the planning area in lower Cook Inlet and the northern Shelikof Strait (Fig. II.E.1). The coastal part of the Sale 149 area deleted by this alternative consists of 154 blocks (about 262,000 ha, or 647,000 acres), about 33 percent of the Alternative I area. The perimeter subarea varies from one to six blocks wide (approximately 3-18 miles [mi]). The blocks proposed for deletion from the sale area by this deferral alternative include many of the blocks proposed for deletion by Alternative IV, Wildlife Concentration Deferral Alternative; the reasons for deleting these blocks from the sale area as proposed in Alternative V are the same as those reasons stated for Alternative IV.

The Kenai Peninsula Fishermen's Association (KPFA) proposed deleting blocks (1) around the perimeter of the sale area in lower Cook Inlet and the northern part of Shelikof Strait and all of the blocks in the southern part of the strait. The KPFA noted that (1) the proposed sale area north of Anchor Point lies within the heart of the Cook Inlet salmon gillnet fishery, and (2) parts of the sale area between Kalgin Island and Cape Douglas have been identified by the ADF&G as being important to critical fish and wildlife resources. The KPFA also expressed opposition to leasing in these areas because of (1) potential conflicts between commercial-fishing activities and oil-industry operations, (2) the high risk that an oil spill poses to the biological resources, and (3) as demonstrated by a recent spill (Kenai Pipe Line Co. oil spill of January 4, 1992, in Nikiski), the lack of technology to successfully contain and clean up a spill in Cook Inlet.

The deferral alternative as proposed by the KPFA is based, in part, on information contained in *Resource Report for Cook Inlet Sale No. 60* (ADF&G, 1988). The blocks (tracts) identified for deferral are the same as those that the ADF&G identified in the report as "hazardous" because of the (1) physical environment (tidal transport, wind transport, and circulation), (2) importance of the coastal fish and wildlife resources, and (3) vulnerability of these resources to oil from spills occurring within some parts of the area or outside but transported into the area. As noted in the report, this threat to the biological resources largely is based on the stated assumed inability of present cleanup technology and equipment to cope with the extreme environmental conditions occurring in the area.

Deleting blocks around the perimeter of the planning area in lower Cook Inlet and northern Shelikof Strait would address scoping concerns expressed regarding (a) potential effects of habitat disturbance and alteration and oil spills from platforms on the marine mammals, seabirds, and fishes and shellfish (including those species commercially exploited) and their habitats in these areas; (b) potential effects to areas of subsistence use; and (c) potential effects to areas important for their intrinsic wilderness values. It is not anticipated these deletions would afford much protection in the event of a tanker spill.

(3) **Alternative VI, Pollock-Spawning Area Deferral Alternative:** The Pollock-Spawning Area Deferral Alternative would offer for leasing the lower Cook Inlet part of the Sale 149 area (Fig. II.F.1); the Shelikof Strait part of the sale area, 42 blocks—about 10 percent of the Alternative I area (about 77,000 ha or 190,000 acres)—would be deleted. Shelikof Strait is a biologically important area supporting extensive

commercial fisheries, numerous seabird colonies, and endangered and threatened and nonendangered marine mammals. The Steller sea lion is listed as a threatened species and is common to the waters of Shelikof Strait. The Pacific harbor seal population in the northern and western Gulf of Alaska has been declining over the last decade.

Deletion of the Shelikof Strait blocks from the Sale 149 area was proposed by the National Oceanic and Atmospheric Administration, FWS, Marine Mammal Commission, the Steller Sea Lion Recovery Team, State of Alaska, Kodiak Island Borough, Lake and Peninsula Borough (King Salmon, Alaska), various public interest organizations and individuals, and the State of Oregon.

Deleting the blocks in Shelikof Strait would address scoping concerns expressed regarding (1) potential effects of habitat disturbance and alteration and oil spills on the marine mammals (including the threatened and endangered species), seabirds, fishes and shellfishes (including those species commercially exploited, especially pollock), and their habitats in this area; (2) potential effects to subsistence-use areas and resources; (3) disturbance to fish and wildlife; and (4) potential effects to areas important for their intrinsic wilderness values.

(4) **Alternative VII, General Fisheries Deferral Alternative**: This alternative would offer for leasing only those blocks in the central part of the planning area in lower Cook Inlet and the northern Shelikof Strait (Fig. II.G.1). The coastal part of the Sale 149 area deleted by this alternative consists of 216 blocks (about 371,000 ha or 917,000 acres), about 46 percent of the Alternative I area. The perimeter subarea varies from one to six blocks wide (approximately 3-18 mi). The blocks proposed for deletion from the sale area by this deferral alternative include many of the blocks proposed for deletion by Alternatives IV, V, and VI. The reasons for deleting the blocks from the sale area as proposed by Alternative VII are the same as those reasons stated for Alternatives IV, V, and VI.

b. Alternatives Not Selected for Inclusion in the EIS:

(1) **Delay the Sale for at Least 3 Years**: This alternative, suggested during the scoping process, recommends delaying the sale until (1) information is released to the public from the studies conducted to evaluate the environmental effects of the *Exxon Valdez* oil spill and the recovery rates of the various biological populations and (2) current baseline environmental data, especially water-quality data for the planning area are available.

An alternative to delay Sale 149 for 2 years is recommended to be analyzed in the EIS. The MMS anticipates that the difference between the amount of information available after 3 years is not expected to be significantly different than the amount of information available after 2 years. It was anticipated that the information about the effects of the *Exxon Valdez* oil spill would be in the environmental effects analysis in this EIS and that MMS's current water-quality-study results would be available for the final if not the draft EIS.1 The State and Federal Governments' litigation with Exxon Corporation was settled in 1992. All State and Federal data have been released to the public; in 1992 State and Federal data on the *Exxon Valdez* oil spill (EVOS) were presented at a conference in Anchorage, and in 1995 a second conference on the EVOS was held in Anchorage. Exxon Corporation has also released studies and presented their data at an American Society for Testing Materials conference.. Studies funded by the Exxon Valdez Trustees Council investigating recovery have also bee made available to the public. Much of this data has been analyzed, synthesized and incorporated in Section III, Description of the Affected Environment, and Section IV, Environmental Consequences.

(2) **Buffer Zones Around Marmot Island and Latax Rocks to Protect the Steller Sea Lion**: Buffer zones (10-20-mi radius) around Marmot Island, Latax Rocks, and Tombstone Rocks were suggested at the Kodiak Scoping Meeting to help protect the Steller sea lion. Establishing buffer zones around these area is not recommended as deferral alternatives because of their distance from the Sale 149 area. Marmot Island lies east of Afognak Island and about 50 mi from the Sale 149 area. Latax Rocks are located in Stevenson Entrance about 5 mi north of Shuyak Island and about 15 mi from the sale area. Tombstone Rocks are located about 1 mile off a Peninsula separating Halibut and Gurney Bays along the western side of Kodiak Island. The location of these areas outside of the proposed sale puts them beyond the scope of any deferral.

3. Mitigating Measures:

Mitigating Measures Suggested during the Scoping Process (Sec. I.D.3.a):

Mitigating Measures that Are Part of the Proposed Action and Alternatives:

Stipulations:

No. 1—Protection of Archaeological Resources*
No. 2—Protection of Biological Resources
No. 3—Orientation Program
No. 4—Transportation of Hydrocarbons

Information to Lessees:

No. 1—Information on Bird and Marine Mammal Protection
No. 2—Information on Sensitive Areas to be Considered in the Oil-Spill-Contingency Plans
No. 3—Information on Steller Sea Lion
No. 4—Information on Coastal Zone Management
No. 5—Information on Minimizing Potential Conflicts Between Oil and Gas and Fishing Activities
No. 6—Information on Oil-Spill-Response Preparedness

Potential Mitigating Measures:

Information to Lessees:

No. 7—Information on Discharges into the Marine Environment
No. 8—Information on Community Monitoring of the Marine Environment

Mitigating Measures Developed in Response to Comments Received on the Draft EIS (Sections II.J.2 and V.A.2.b):

Potential Mitigating Measures:

Stipulations:

No. 5—Restriction on Multiple Operations
No. 6—Seasonal Drilling Restriction
No. 7—No Surface Entry during Development and Production

a. Mitigating Measures Suggested During the Scoping Process: The following suggestions for mitigating measures to protect certain resources were received and are discussed below. Section II.H contains (1) mitigating measures that are part of the proposed action and the alternatives and (2) potential mitigating measures that are proposed for analysis. It should be noted that a Secretarial decision on the potential mitigating measures will not be made until the Notice of Sale has been approved. (Also, several mitigating measures were suggested in the response to comments of the draft EIS for Sale 149, and these are described in Sections II.J.2 and V.A.2.b.)

(1) Stipulations (Stipulations that Are Considered Part of the Proposed Action and Alternatives):

No. 1—Protection of Archaeological Resources*
No. 2—Protection of Biological Resources
No. 3—Orientation Program
No. 4—Transportation of Hydrocarbons

***Protection of Archaeological Resources** This stipulation was suggested during the scoping process and included in the draft EIS for Sale 149. However, as explained below, the stipulation was deleted from the final EIS. This stipulation is intended to protect cultural resources from damage due to offshore activities and would apply to all blocks. Since 1973, the USDOI has included a stipulation on the OCS mineral lease tract notifying potential lessees that, where applicable, archaeological resource surveys and reports will be required. In order to convert the requirements of the archaeological lease stipulation into regulations, a proposed rule was published by MMS on October 12, 1993 (58 *FR* 52731). The final rule amends the regulatory program of the MMS to state specifically the authority of MMS to require lessees or operators to conduct archaeological resource surveys and submit reports prior to exploration, development and production, or installation of right-of-way pipelines; the effective date of the rule is November 21, 1994 (59 *FR* 53091). Converting the requirements of the archaeological lease stipulation into regulations will eliminate this stipulation from future MMS OCS leases and the need for a Secretarial decision on this mitigating measure.

Protection of Biological Resources states that the Regional Supervisor, Field Operations (RS/FO), may require lessees to conduct a biological survey if the RS/FO identifies any biological habitats that may require additional protection. The RS/FO may require lessees to relocate the site of operations or modify the conduct or timing of operations to protect the resources. The measure also provides protection for areas of biological significance discovered during the conduct of operations. Adoption of this measure would provide a formal mechanism for identifying and mitigating effects to important or unique biological populations or habitats. This measure has been recommended for incorporation into the regulations under 30 CFR 250. Should final rulemaking action occur prior to issuance of any leases resulting from this proposed sale, this stipulation will not be necessary. This stipulation has been part of previous OCS sales.

Orientation Program addresses the continuing concern that uninformed workers and subcontractors could unknowingly destroy or damage the environment, be insensitive to local historical or cultural values, or unnecessarily disrupt the local economy. Previous EIS analyses indicate that this measure provides positive mitigating effects in that it makes industry personnel aware of environmental, social, and cultural values in the region of operations. Raising industry workers' awareness of the environmental, social, and cultural context in which they work also may minimize conflicts between fishing and subsistence activities and activities of the oil and gas industry. This stipulation has been part of previous OCS sales.

Transportation of Hydrocarbons addresses an area of concern related to OCS oil and gas activities—the transportation of the product from the field to the shore. This stipulation requires that pipelines be used to transport oil from the leases to shore if (a) pipeline rights-of-way can be determined and obtained, (b) laying such pipelines is technologically feasible and environmentally preferable, and (c) pipelines can be laid without a net social loss. The stipulation does not preclude offshore loading or use of tankers. Rather, the stipulation provides a formal way of selecting the environmentally preferable method of transporting petroleum from a lease-sale area. It also informs the lessee that (1) MMS reserves the right to require the placement of pipelines in certain designated management areas and (2) pipelines must be designed and constructed to withstand the hazardous conditions that may be encountered in the sale area.

(2) **Information to Lessee Clauses:** Information to Lessees (ITL's) Numbers 1 through 6 are considered part of the Proposed Action and Alternatives. The ITL's Numbers 7 and 8 are considered Potential Mitigating Measures and are not part of the Proposed Action and Alternatives.

(Mitigating Measures that Are Part of Proposed Action and Alternatives):

No. 1—Information on Bird and Marine Mammal Protection
No. 2—Information on Sensitive Areas to be Considered in the Oil-Spill-Contingency Plans
No. 3—Information on Steller Sea Lion
No. 4—Information on Coastal Zone Management
No. 5—Information on Minimizing Potential Conflicts Between Oil and Gas and Fishing Activities
No. 6—Information on Oil-Spill-Response Preparedness

(Potential Mitigating Measures):

No. 7—Information on Discharges into the Marine Environment
No. 8—Information on Community Monitoring of the Marine Environment

No. 1—Information on Bird and Marine Mammal Protection is intended to help minimize behavioral disturbance of wildlife, particularly at known concentration areas. This ITL clause (1) reminds lessees of their responsibilities under the ESA and the MMPA, (2) includes information on "taking" and minimum distances of operations from wildlife, and (3) contains a recommendation that all aircraft operators fly at altitudes no lower than 1,500 feet when in transit between support bases and exploration sites, and that vessels maintain a 1-mi horizontal separation from each other. This ITL also has been part of previous Alaska OCS sales.

No. 2—Information on Sensitive Areas to be Considered in the Oil-Spill-Contingency Plans is intended to identify for lessees special areas and lessee responsibilities within these areas. This ITL clause (1) identifies areas of special biological sensitivity and advises lessees that they have the primary responsibility for identifying biologically sensitive areas in their Oil-Spill-Contingency Plans (OSCP's) and providing for specific protective measures. These areas must be considered in OSCP's as required by 30.CFR 250.42. Specific protective measures must be adopted for these areas and any additional areas that may be identified during review of exploration and development and production plans. This ITL also has been part of previous Alaska OCS sales.

No. 3—Information on Steller Sea Lion advises the lessees that the Steller sea lion is listed as a threatened species and that lessees must conduct their activities in a manner that will limit and minimize potential encounters and interaction with Steller sea lions. The lessee is encouraged to coordinate with the NMFS to minimize adverse encounters.

No. 4—Information on Coastal Zone Management advises lessees that the Alaska Coastal Management Program, as amended by local district programs, contains policies that may be relevant to activities associated with leases from Sale 149 and identifies policy areas that may be applicable. The lessees are encouraged to consult and coordinate early with those involved in coastal management reviews.

No. 5—Information on Minimizing Potential Conflicts Between Oil and Gas and Fishing Activities addresses the need to establish communication with commercial and subsistence fisheries groups in the area to minimize the potential conflicts between oil and gas activities and commercial and subsistence fisheries.

No. 6—Information on Oil-Spill-Response Preparedness emphasizes lessees' responsibilities under MMS regulations 30 CFR 250.42, Oil Spill Contingency Plans, and 30 CFR 250.43, Training and Drills. The purpose of this ITL is to ensure that lessees (1) are ready to respond to an oil spill that might occur as a result of their operations and (2) have the appropriate equipment and trained personnel available to conduct cleanup operations.

No. 7—Information on Discharges into the Marine Environment reminds lessees that, in accordance with the Clean Water Act, National Pollution Discharge Elimination System (NPDES) Permits are required, and that the RS/FO may restrict the rate of drilling fluid discharges or prescribe alternative methods (e.g., zero-discharge criteria may be required) (30 CFR 250.40(b)).

No. 8—Information on Community Monitoring of the Marine Environment notifies lessees that local communities have indicated that they will monitor the nearby marine environment during any OCS-related activity, and they will report the results to MMS who will use that information when reviewing lessee's activities.

Although these requirements largely reiterate existing regulations, the ITL represents the commitment of MMS to safe operations and is responsive to comments received during scoping and to the Call.

b. Mitigating Measures not Recommended for Further Study:

(1) **Seasonal Drilling Restriction (SDR)**: The KPFA recommended that exploratory drilling and seismic activity be prohibited in areas north of Anchor Point and between Kalgin Island and Cape Douglas between May 1 and August 30. The KPFA is opposed to leasing in these areas due to their concern about potential conflicts between commercial-fishing and oil-industry operations, especially seismic surveys, and the high resource risks involved. Concern was expressed that proposed OCS activity would not be compatible with the Cook Inlet salmon gillnet fishery (areas north of Anchor Point).

The Kodiak Island Borough also recommended seasonal drilling restrictions to reduce or eliminate gear conflicts between oil and fishing industries throughout the entire Call area based on high fisheries and habitat values and projected low oil and gas resources in the area.

When the Kodiak Island Borough was contacted to clarify this comment, they made it plain that the topic of concern was prelease seismic activities. Further investigation indicated that this also applied to the KPFA comment.

The geophysical and commercial-fishing industries have a demonstrated ability to work together to avoid conflicts. The Oil/Fish Group of Alaska was formed in 1983 by several major oil companies and major fishing and processing organizations operating in Alaska. The purpose of the group is to provide a forum for industry communication, education, and resolution of potential problems relating to operations in Alaska. A goal is the successful coexistence of commercial-fishing, processing, and oil-industry activity in Alaskan offshore areas.

Geological and geophysical (G&G) activities for oil and gas exploration and scientific research are authorized under 30 CFR 251 and must be conducted so that they do not: (1) interfere with or endanger operations under any lease issued or maintained pursuant to the OCSLA; (2) cause harm or damage to aquatic life; (3) cause pollution; (4) create hazardous or unsafe conditions; (5) unreasonably interfere with or harm other uses of the area; or (6) disturb cultural resources. Prior to any G&G activity in Federal waters, MMS requires that a permit application be submitted for regulatory review. The MMS conducts a NEPA review of every permit application to determine if significant environmental effects may occur and if mitigation measures need to be applied to minimize possible adverse effects. A standard stipulation attached to permits recommends the industry contact the ADF&G or the NMFS for information on the fisheries and fishing activities in the proposed area of operations to minimize potential conflicts with fishing activities. The G&G industry also coordinates their activities with the commercial-fishing organizations prior to conducting operations to ensure that adverse encounters between them will be minimized. A copy of the approved permit is forwarded to appropriate offices of the ADF&G, other Federal Agencies, and commercial-fishing organizations.

In summary, the addition of a stipulation to the lease sale would have no effect on presale seismic operations. Also, it is highly unlikely that the presence of one or two drilling platforms/vessels would seriously displace drift-gillnet operations, because fishing vessels routinely navigate to avoid various kinds of obstacles. The ITL on Fisheries and Oil-Industry Cooperation was developed to minimize any potential conflicts during postlease-sale operations.

On further investigation, when trying to design a stipulation, it was discovered that there are no seasons when the proposed prohibited areas that could be included in any SDR would be devoid of fisheries resources or even any periods when most population numbers would be at a seasonally low ebb. Thus, any SDR would be tantamount to no drilling at all. This is examined in the No Sale Alternative.

Even though not mentioned by any of the commenters, the possible use of an SDR for the protection of nesting seabirds and marine mammals was considered. The 5-year final CP (USDOI, MMS, 1992) identified the biggest risk and effect-producing factors to these two resources as oil spills originating from tankers and noise and traffic disturbance of concern in selected areas. The SDR would not alleviate effects from tanker spills. An SDR could provide protection to birds and marine mammals during critical periods, but this need also could be met with the "Protection of Biological Resources" stipulation or the ITL, "Information on Minimizing Potential Conflicts between Oil and Gas and Fishing Activities," which are proposed as part of the proposal. The stipulation provides protection to nesting seabirds and marine mammal haulout areas by identifying the areas at risk and requiring that the lessee avoid these areas. The ITL also provides additional protection by advising lessees that exploration, development, and production should minimize any potential conflicts between the oil and gas industry and fishing activities.

However, as noted in Section I.D.3, a limited Seasonal Drilling Restriction Stipulation (Stipulation No. 6) has been included in the list of potential mitigating measures that were developed in response to comments received on the draft EIS. The seasonal drilling restriction stipulation was developed in response to comments from the State of Alaska (Sec. V.B.2) in response to concerns expressed about potential conflicts between petroleum-exploration drilling operations and commercial fishing activities. In their comments, the State of Alaska identified a corridor along the northeastern side of the Sale 149 area which includes an area where fishing activities often are restricted as a management tool to control the catch of specific salmon species. The area affected by the proposed seasonal drilling restriction is located along the northeastern perimeter of the sale area; it consists of a corridor that is about 6 miles wide and extents from about 9 miles south of Anchor Point to about 6 miles north of Ninilchik (the affected blocks are defined in the stipulation--Sec. II.J.2.a).

The MMS will continue to meet with those groups or individuals who have interests in the Cook Inlet fisheries. Other areas may be identified where there may be potential conflicts between petroleum-exploration drilling operations and commercial fishing activities. If these areas can be specified prior to the publication of the Notice of Sale, the area(s) affected by the proposed seasonal drilling restriction could be modified to reflect any new information.

(2) **Environmental Survey and Monitoring Program**: These measures were recommended during scoping meetings by environmental groups and the public in Anchorage, Homer, Kodiak, Nanwalek, and Seldovia who expressed concern over allegedly deteriorating water quality of Cook Inlet.

Because of the currents and tides in Cook Inlet, a monitoring program that can be required of any potential lessee would have to be developed on a case-by-case basis. To create a feasible plan that could detect potential problems, sampling stations would have to be established completely around the platform and samples taken at various depths constantly during any discharge operations. Sampling at the point of discharge provides a more positive check on potential pollutants because of the rapid dispersal of the discharge by the complex currents and winds of the inlet.

This point-of-discharge sampling is required under the USEPA's NPDES permits, and MMS and USEPA are discussing possible MMS participation in this compliance action. In addition, if any problems are encountered, the ITL on Discharges Into The Marine Environment informs the lessee that the RS/FO has the authority to ban all discharges, even when the lessee has a valid NPDES permit.

In addition, 30 CFR 250.33 and 34 require the lessee to submit exploration and development and production plans that include meteorological and oceanographic data; flora and fauna information that includes both pelagic and benthic communities, migratory species, and critical habitats; commercial-fishing information; subsistence hunting and fishing information; archaeological and cultural resources information; and other information that the RS/FO may require the lessee to provide through resource surveys.

Also, the Protection of Biological Resources Stipulation and the Bird and Marine Mammal Information ITL clause also may require survey activities.

E. Indian Trust Resources: The MMS anticipates that the proposed action or alternatives will have no significant effects on Indian Trust Resources. The Federal Government does not recognize the validity of claims of aboriginal title, and associated hunting and fishing rights, that have been asserted for unspecified portions of the sale area. However, while MMS does not recognize these resources as Indian Trust Resources, this EIS considers the potential effects of lease-sale activities on them.

F. Executive Order 12898: Environmental Justice: The environmental-justice policy based on Executive Order 12898 requires agencies to incorporate environmental justice into their missions by identifying and addressing environmental effects of their proposed programs on minorities and low-income populations and communities. The USDOI has developed guidelines in accordance with the Presidential Executive Order on Environmental Justice. The MMS participated in the development of these guidelines. The MMS's existing process of involving all affected communities and Native American and minority groups in the NEPA-compliance process meets the intent and spirit of the Executive Order. However, we are continuing to identify ways to improve the input from all Alaskan residents, not only in commenting on official documents but also contributing their knowledge to the scientific and analytical sections of the EIS.

Environmental concerns generally were identified during the scoping process and in response to comments on the draft EIS for Sale 149. The potential effects of Sale 149 on the issues raised by these concerns are addressed in those sections that analyze the effects of the sale on the Economy, Subsistence-Harvest Patterns, and Sociocultural Systems—Sections IV.B.1.h, j, and k, respectively.

The effects on human health from permitted discharges can be assessed based on the type of information about the potential discharges and direct human exposure, as shown in Appendix J, Fate and Effects of Exploratory Phase Oil and Gas Drilling Discharges in the Cook Inlet Planning Area, Lease Sale 149, Human Health Impacts. Human health also can be threatened in oil-spill-affected areas, but these risks can be mitigated through timely warnings about a spill occurrence, forecasts about which areas might be affected and, if necessary, minimizing possible exposure by evacuation, and avoidance of marine and terrestrial foods that might be affected. Federal and/or State agencies with health-care responsibilities would have to sample the food sources and test for possible contamination. Testing of food sources from spill-affected areas may have to continue for several seasons, especially if there was contamination. Even though testing may not reveal any contamination or, in the case of contamination, indicate levels have declined to prespill levels, there would be the perception that food sources from spill-affected areas could be tainted and not suitable for consumption.

An example of this testing was provided by the Oil Spill Health Task Force in response to the *Exxon Valdez* oil spill (State of Alaska, ADF&G, 1991). The task force collected and tested subsistence foods from different parts of the EVOS-affected area. Continued research into the quality of subsistence resources was funded by the *Exxon Valdez* Oil Spill Trustees Council and coordinated through the Subsistence Division, ADF&G.

G. <u>Significant Differences Between the Draft EIS and the Final EIS</u>: The following summarizes the significant changes that have been made in the final EIS as a result of public review of the draft EIS. These changes include (1) the addition of two deferral alternatives, (2) the deletion of a stipulation, (3) the change of an ITL to a stipulation and added language to include subsistence fisheries, (4) the addition of three stipulations, and (5) the analysis of several additional factors.

- Two deferral alternatives were added to the final EIS in response to comments expressing concerns related to commercial fishing in the northern part of lower Cook Inlet and subsistence activities in the southern part of lower Cook Inlet. The Northern Deferral Alternative, Alternative VIII, proposes to delete from the Sale 149 area all of the blocks north of Anchor Point. The Kennedy Entrance Alternative, Alternative IX, proposes to delete from the sale area, a row of nine blocks west of the Barren Islands and a row of eight blocks west of the southwestern end of the Kenai Peninsula. Most of the blocks in these two deferral alternatives were part of other deferral alternatives analyzed in the draft EIS. Additional information on these two deferral alternatives is presented in Sections II.H and II.I and Section V.A.2.a (1) and (2).

- The Protection of Archaeological Resources Stipulation was deleted from the final EIS. The requirements of this stipulation became part of MMS's regulatory program in November 1995 (Sec. I.D.3.a(1)). Converting the requirements of the archaeological lease stipulation into regulations eliminates the need for this stipulation in future OCS leases.

- The ITL, Information on Minimizing Potential Conflicts between Oil and Gas and Fishing Activities, was changed to the stipulation, Protection of Fisheries Stipulation, and wording was added to the text of the stipulation to include subsistence and sport fisheries (Sec. II.J.1.a). The purpose of this stipulation is to ensure the petroleum industry and the participants in commercial- and subsistence- and sport-fishing activities have a mechanism to coordinate their activities and minimize spatial-use conflicts.

- Three potential stipulations were added to the final EIS to minimize potential space-use conflicts between the oil and gas exploration and development and production activities and commercial-fishing activities (Sec. II.D.2). These stipulations are Restriction on Multiple Operations Stipulation (Stipulation No. 5), Seasonal Drilling Restriction Stipulation (Stipulation No. 6), and No Surface Entry during Drilling Development and Production Stipulation (Stipulation No. 7).

- The Information on Sensitive Areas to be Considered in the Oil-Spill-Contingency Plans, ITL No. 2, has been revised to include some additional areas of special biological and cultural sensitivity suggested by comments received on the draft Sale 149 EIS. The Information on Coastal Zone Management, ITL No. 4, has been revised to notify potential lessees that specific coastal districts have enforceable policies that have been incorporated into the Alaska Coastal Management Program. The Information on Oil-Spill-Response Preparedness, ITL No. 5, has been revised to address concerns regarding the ability of the lessee to protect communities and important resources from the adverse effects of an oil spill.

- The analyses in Section IV.B have been revised to include (1) the social, psychological, and cultural effects that the Sale 149 pre- and postlease sale and development and production process have on individuals and communities adjacent to the sale area and (2) the effects of Sale 149 on the Kodiak commercial fisheries (Sec. V.B). Where comments warranted other changes or presented new and/or substantive information, revisions were made to the appropriate text in the EIS; references to the revised sections are presented in the responses to the specific comments.

SECTION II

ALTERNATIVES INCLUDING THE PROPOSED ACTION

Section II Table of Contents

II. ALTERNATIVES INCLUDING THE PROPOSED ACTION:

A. Alternative I, The Proposal:

A. Alternative I, The Proposal: Alternative I would offer 402 whole and partial blocks (about 0.8 million hectares [ha] or 1.98 million acres) of the Cook Inlet Planning Area for leasing; this area is located in lower Cook Inlet and the northern part of Shelikof Strait (Fig. II.A.1). For Alternative I, three hypothetical scenarios have been developed to assess the potential environmental effects of the sale; these effects are analyzed in Sections IV.B through IV.F. The scenarios are based on an estimated range of oil resources for a low case, base case, and high case. These ranges consider available geologic as well as economic information. The ranges reflect the uncertainty associated with estimating potential resources prior to exploratory drilling and are believed to be more realistic indicators of resources that actually may be present than estimates based on single numbers. Although in this section the predicted resources for the low, base, and high cases are presented in a range, in Section IV these resources are presented as a single number for analytical purposes. The environmental analysis of the Proposal is presented in Section IV.

1. **Low Case:** The low case of the proposed action features an exploration-only scenario. It is assumed no commercially producible resources would be discovered. Exploratory drilling activities are expected to occur in 1997 and 1998 (Appendix A). During this period, three exploration wells would be drilled; only one well would be drilled at a time. The types of drilling units most likely to be used would be heavy-duty semisubmersibles or jackups. The most likely support base for exploration-drilling activities would be in the Kenai/Nikiski area, but alternative bases may be located elsewhere on the Kenai Peninsula.

2. Base Case:

a. **Resource Estimated Range and Basic Exploration, Development, and Production Assumptions for Effects Assessment:** For Alternative I, the range of resources varies from a base-case low of 100 million barrels (MMbbl) produced over the 19-year life of the field to 300 MMbbl produced during the same period (Appendix A and Table II.A.1). The resource range is based on a range of assumed values of produced crude oil. The value per barrel of oil assigned ranged from $16 to $22. The $6-difference in the price per barrel of oil is equivalent to a nearly threefold expansion in production and a two- to threefold expansion in related infrastructure. The oil-field-development scenario for the proposed action is based on the value of a barrel of oil. Table II.A.1 displays the infrastructure and developmental timeframes proposed for base case.

Exploratory drilling activities are expected to occur in 1997 and 1998 (Table II.A.1). During this period, an estimated one to five exploration wells and three to eight delineation wells would be drilled; only one well would be drilled at a time. The types of drilling units most likely to be used would be heavy duty semisubmersibles or jackups. The most likely support base for exploration-drilling activities would be Kenai, but alternative bases may be located elsewhere on the Kenai Peninsula.

Activities associated with development and production would begin in 1999 with the installation of a production platform (Table II.A.1); two to five platforms would be installed during a 2- to 3-year period between 1999 and 2001. The timing and level of production activities are based on an estimated crude-oil-production range of 100 to 300 MMbbl. The estimated level of activities associated with crude-oil production is based on this range; the low end of the activity range is associated with the 100-MMbbl estimate and the high end with 300 MMbbl. As noted above, the 100-MMbbl estimate is based on a barrel of crude oil selling for $16 and the 300-MMbbl estimate on oil selling for $22. Between 2000 and 2002, an estimated 24 to 84 production and service wells would be drilled using 1 to 4 drilling rigs. Crude-oil production is estimated to begin in 2002 or 2003 and continue through 2020 or 2021; the production life of the Sale 149 field(s) is expected to be 19 years. Peak production is estimated to occur between 2003 and 2008; peak production would range from 8 to 25 MMbbl per year. Steel production platforms similar to those used in upper Cook Inlet may be the most likely type of platform used to develop and produce Sale 149 oil (Appendix A). Depending in part on site and environmental conditions, the size and shape of the field, and the oil reserves, other types of platforms that might be used in Sale 149 activities include concrete gravity-based platforms similar to those installed in the North Sea or a semisubmersible floating production system with subsea wells. Support for development and production activities most likely would be from a shore base in the Kenai/Nikiski area.

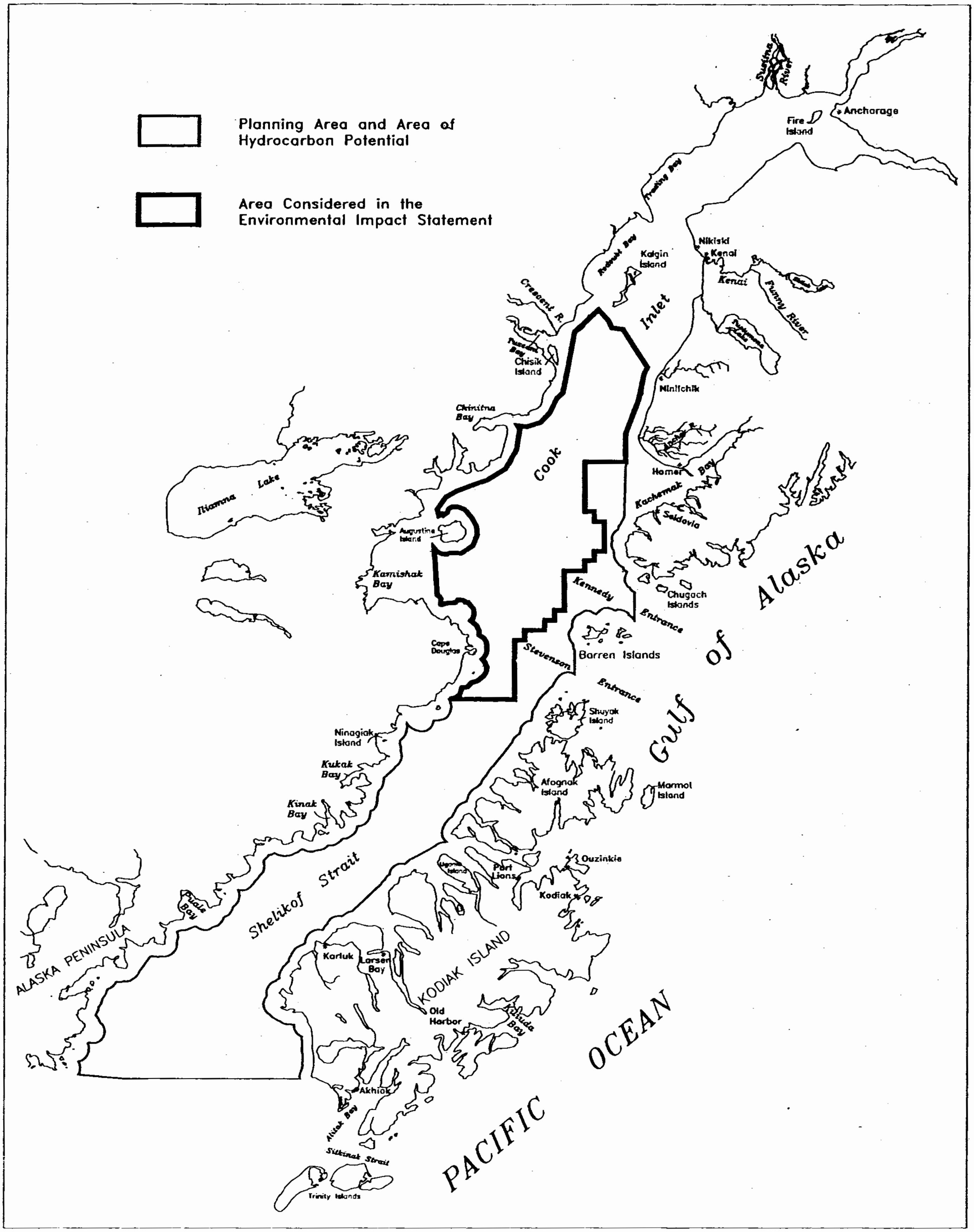


Figure II.A.1. Sale 149 Area of Sale (Proposal).

Table II.A-1
Summary of Basic Exploration, Development and Production, and Transportaion Assumptions for Alternatives I, IV, V, VI, VII, VIII, and IX (Cook Inlet Oil and Gas Lease Sale 149)

EXPLORATION

PHASE Activity/Event	Alternative I						Alternative IV (Wildlife Concentration)		Alternative V (Coastal Fisheries)		Alternative VI (Pollock-Spawning Area)		Alternative VII (General Fisheries)		Alternative VIII (Northern)		Alternative IX (Kennedy Entrance)	
	Low Case		Base Case		High Case													
	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame
EXPLORATION																		
Well Drilling																		
		1997-1998		1997-1998		1997-1999		A		A		A		A		A.		A
Exploration Wells	3		1-5		8-20		1-4		1-3		1-4		1-2		1-3		1-5	
Delineation Wells	--		3-8		12-24		2-6		2-5		2-6				2-5		3-8	
Drilling Discharges																		
Drilling Muds[1] (Short Tons)	1,080		1,440-4,680	1997-1998	7,200-15,840		1,080-3,600		1,080-2,880		1,080-3,600		360-720		1,080-2,880		1,440-4,680	
Cuttings[1] (Short Tons)	1,320		1,760-5,270		8,800-19,360		1,320-4,400		1,320-3,520		1,320-4,400		440-880		1,320-3,520		1,760-5,270	
Support Activities																		
Helicopter Flights[2]	180-270	1997-1998	240-1,170	1997-1998	1,200-3,960	1997-1999	180-900	A	180-720	A	180-900	A	60-180	A	180-720	A	240-1,170	A
Supply-Boat Trips[3]	21-33		28-143		140-484		21-110		21-88		21-110		7-22		21-88		28-143	
Shallow-Hazards Site Surveys																		
Total Area Covered[4] (mi^2)	26.7	1997-1998	35.5-115.4	1997-1998	177.6-390.7	1997-1999	26.6-88.8	A	26.6-71.0	A	26.6-88.8	A	8.88-17.8	A	26.6-71/0	A	35.5-115.4	A
Total Number of Days Required[5]	6		8-26		40-88		6-20		6-16		6-20		2-4		6-16		8-26	

Table II.A-1 (Continued)

Summary of Basic Exploration, Development and Production, and Transportaion Assumptions for Alternatives I, IV, V, VI, VII, VIII, and IX (Cook Inlet Oil and Gas Lease Sale 149)

DEVELOPMENT AND PRODUCTION

	Alternative I						Alternative IV (Wildlife Concentration)		Alternative V (Coastal Fisheries)		Alternative VI (Pollock-Spawning Area)		Alternative VII (General Fisheries)		Alternative VIII (Northern)		Alternative IX (Kennedy Entrance	
	Low Case		Base Case		High Case													
PHASE Activity/Event	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame
DEVELOPMENT AND PRODUCTION																		
Platforms																		
Number			2-5		8-20		2-4		1-3		2-4				1-3		2-5	
Installation				1999-2001		2000-2005		A		A		A				A		A
Production- and Service-Well Drilling																		
Number of Wells			24-84	2000-2002	122-360	2000-2006	24-67	A	12-54	A	24-66	A			12-54	A	24-84	A
Production (Estimated Range)																		
Total (MMbbl)			100-300	2002-2021	550-1,100	2003-2021	80-240	A	70-210		75-225		(40)		70-210	A	100-300	
Peak Yearly (MMbbl)			8-25	2004-2008	46-92	2004-2008		A		A		A					8-25	A
Monthly Support Activities																		
Helicopter Flights[6]																		
During Drilling			1,080-3,780	2000-2002	5,490-16,200	2000-2006	1,080-3,015	A	540-2,430	A	1.080-2,970	A			540-2,430	A	1,080-3,780	A
After Drilling			5,928-14,820		23-712-59,280		5,928-11,856		2,964-8,892		5,928-11,856				2,964-8,892		5,928-14,820	
Supply-Boat Trips[7]			1,976-4,940	2000-2021	7,904-19,760	2000-2021	1,976-3,952	A	988-2,964	A	1,976-3,952	A			988-2,964	A	1,976-4,940	A
Drilling Discharges																		
Drilling Muds[8] (Short tons)			1,920-31,080	2000-2002	9,760-133,200	2000-2006	1,920-24,790	A	960-19,980	A	1,920-24,420	A			960-19,980	A	1,920-31,080	A
Cuttings[8] (Short tons)			13,440-47,040		68,320-201,600		13,440-37,520		6,720-30,240		13,440-36,960				6,720-30,240		13,440-47,040	
Shallow-Hazards Surveys																		
Total Area Covered[9] (mi^2)			71.0-177.6	1999-2001	284.2-710.4	2000-2005	71.0-142.1	A	35.5-106.6	A	71.0-142.1	A			35.5-106.6	A	71.0-177.6	A
Total Days Required[10]			14-35		56-140		14-28		7-21		24-28				7-21		14-35	

Table II.A-1 (Concluded)
Summary of Basic Exploration, Development and Production, and Transportaion Assumptions for Alternatives I, IV, V, VI, VII, VIII, and IX (Cook Inlet Oil and Gas Lease Sale 149)

TRANSPORTATION

	Alternative I						**Alternative IV (Wildlife Concentration)**		**Alternative V (Coastal Fisheries)**		**Alternative VI (Pollock-Spawning Area)**		**Alternative VII (General Fisheries)**		**Alternative VIII (Northern)**		**Alternative IX (Kennedy Entrance**	
	Low Case		**Base Case**		High Case													
PHASE Activity/Event	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame	Estimated Range	Time-frame
TRANSPORTATION																		
Oil Pipelines																		
Installation				2001-2002		2001-2002		A		A		A				A		A
Offshore Length (mi)			75-150		150-200		75-140		65-110		75-100				65-110		75-150	
OIL SPILLS -- See Tables IV.A.2-2 and IV.A.2-4																		

Source: Appendix A

A The timeframe is assumed to be similar to that for Alternative I (base case).

[1] Amounts are based on each exploration and delineation well using 360 tons (dry weight) of drilling muds and producing 440 tons (dry weight) of cuttings.

[2] The number of helicopter flights is based on the assumption that there will be one flight per day per well for 60 to 90 days.

[3] The number of supply-boat trips is based on the assumption that there will be one trip per week per well for 60 to 90 days.

[4] MMS's site-clearance seismic-survey requirements specify a minimum area of 23 km^2 (about 8.9 mi^2—an area that is about equal to one full OCS lease block) for a site-specific survey.

[5] The time required to comple a site-clearance survey is estimated to be 2 days.

[6] The number of helicopter flights is based on the assumption that there will be one flight per day per well for 45 days.

[7] The number of helicopter flights is based on the assumption that there will be 3 flights per week per platform for 19 years.

[8] The number of supply-boat trips is based on the assumption that there will be one trip per week per platform for 19 years.

[9] Amounts are based on each production or service well using between 80 and 370 tons (dry weight) of drilling muds and producing 560 tons (dry weight) of cuttings.

[10] MMS's site-clearance seismic-survey requirements specify a minimum area of 92 km^2 (about 35.5 mi^2) for a blockwide survey.

[11] The time required to comple a site-clearance survey is estimated to be 7 days.

Sale 149 oil most likely would be transported from the field(s) to the Nikiski industrial complex through approximately 75 to 150 miles (mi) of 12-inch (in) offshore pipeline (Table II.A.1). Pipeline installation would occur between 2001 and 2002.

b. **Transportation-Component Analysis for the Base-Case Scenario**: The purpose of this subsection generally is to discuss (1) the logistics/transportation requirements of the proposed action, (2) the transport activities these requirements may generate, and (3) the existing transportation systems and facilities.

(1) **Surface Transportation**: The primary road systems affected by the base case of the proposed action will be those of Southcentral Alaska. In the base-case scenario, produced crude would be transported by undersea pipeline to the Nikiski petrochemical complex for refining or transport to market.

The ports of Anchorage and Seward would be the probable points of entry for the heavy machinery and material required to construct any additional oil-processing, tanker-dock, or petroleum-storage facilities in Nikiski. Trucked freight would travel by way of the Seward and Sterling Highways to the Kenai Peninsula. Anchorage is approximately 170 mi from a landfall at Nikiski, and Seward is approximately 120 mi away. Average annual daily traffic (AADT) figures for potentially affected highways vary between 1,300 (on Seward Highway south of Kenai Lake) and 5,000+ (Seward Highway between Anchorage and the community of Girdwood) per day. The AADT figures are somewhat misleading, because traffic along these routes is highly seasonal and is strongly influenced by tourism and recreation; however, since 1993, an increasing number of trucks carrying wood chips and lumber products travel the Kenai Peninsula to the Port of Homer and possibly Seward (see Table IV.A.7-1, Timber Industry). Summer traffic can be more than four times that of the winter period and, in selected locations, the traffic differential can reach six times that of the winter period (State of Alaska, Dept. of Transportation/Public Facilities [DOTPF], 1990).

Currently, the highways serving the Kenai Peninsula are 40 feet (ft) wide. This width is composed of two 12-ft lanes with two 8-ft shoulders. The roads are designed with 6-percent grades; in mountainous areas, the roads have occasional four-lane segments for passing. Major highway reconstruction is planned ideally on a 20-year-planning horizon but infrequently responds to a much shorter demand (political) timeframe. Heavy-duty maintenance is based on a 10-year-planning horizon.

Based on the use of 36,000-lb tandem-truck rigs, the proposal probably will generate less than (<) 1,000 trips per year (one way), even at the height of developmental activity (2001-2002). Most of these trips will be devoted to the movement of oil-pipe and construction-related materials from port to construction site. Regarding effects on the highways from the movement of construction materials, the severest degradation of highway pavement takes place during the spring when the road bed is spongy and easiest to fracture (Burkholder, 1992). Large-scale movement of oil-field-related material may cause the State (DOTPF) to limit axle weights in certain seasons and reprioritize its maintenance and reconstruction schedules. In addition to heavy truck traffic, small-vehicle traffic will increase on the Kenai road system from the movement of construction workers to and from work sites; and the area around the communities of Kenai and Soldotna may see an increase in interstitial roads as new subdivisions are constructed.

(2) **Air Transportation**: For the base case, air support for offshore drilling and construction activities is expected to issue from the Kenai Peninsula. There are a number of public and private airstrips and helicopter facilities located at or near the communities of Homer, Kenai, and Nikiski. Many of the workers employed in both the exploration and development phases of the proposed action will be residents of the Kenai peninsula. Those who are not residents will be driving directly to the transport site from other Southcentral Alaskan communities. The airports at Kenai and Homer easily should be able to accommodate the increase in air traffic; both facilities have nearby land available for any type of transient or warehouse construction. Day-to-day logistics support of the offshore platforms probably would issue from a private helicopter pad.

(3) **Marine Transportation**: Marine-support activities for the base case would issue from the Kenai-Nikiski area (possibly from the Rig-Tenders dock). The Kenai-Nikiski area, with its lengthy history of oil-related activities and existing oil-field-support contractors, would provide logistics support for both the exploration and production and developmental phases. Operating from the subject area would be one or possibly two supply boats (depending on the nature of operations). These boats would be responsible for

transporting bulk material to the drill site (drill mud, water, machinery) as well as be on constant standby for emergency situations. The support base as well as the oil terminal could be resupplied by barge or highway from another Southcentral Alaska port. The number of trips per day the support boat(s) would make would decrease from a high of two or more per day during exploration/development into the much less active production phase. The pipelaying barge would be assisted by tugs and primarily could be resupplied by barges from non-Alaskan ports.

In the base-case scenario, after produced crude arrived at Nikiski the oil either would be transshipped to the U.S. west coast or processed for in-State sale. The assumption of transshipment should be evaluated in light of the following two points: (1) Currently 25+ MMbbl are shipped annually from Valdez to Tesoro Petroleum's Nikiski refinery (USDOT, Maritime Administration, 1991). It is likely that production from this lease sale would tend to back out some of the Valdez shipments. (2) ARCO has recently located commercially recoverable quantities of oil in upper Cook Inlet; however, the newly discovered field has not been fully defined. Most of this oil may be shipped to the U.S. west coast.

Large-vessel marine traffic generated by the proposal would focus on two Southcentral Alaskan ports—Seward and Anchorage. These ports are assumed; however, before discussing these facilities, it should be noted that the larger the discovery in lower Cook Inlet the more likely additional port facilities would be built on the Kenai Peninsula, thus making direct marine-cargo shipments to Kenai/Nikiski far more likely. The Port of Seward, located at the head of Resurrection Bay, is a deepwater anchorage and a principal point of entry and exit for Southcentral Alaskan cargoes. The port is served by nine docks (water depths range to 38 ft), a boat harbor, 400 acres of cargo-staging area, a 24,000-square foot (ft^2)-heated warehouse, numerous cranes (up to 140 tons capacity) and, among other infrastructure essentials, it is connected by both road and rail to Southcentral Alaska. The Port of Anchorage is Southcentral Alaska's principal seaport. In addition to being connected to the rest of Alaska by both road and rail, the Port of Anchorage also is located near an international airport. The primary facilities of the port consist of five docks, two petroleum berths, and three general-cargo berths; one of the latter has a 1,600-ft pier that is used primarily for brake-bulk cargo (35-ft-water depth, mean low lower water). The general cargo berths are served by a 27,000-ft^2-heated warehouse, 38 acres of public storage, a 110-acre industrial park, heavy lift cranes (up to 150-ton capacity), and all other necessary infrastructure (U.S. Dept. of Defense, U.S. Army Corps of Engineers, 1993).

Unlike marine traffic transiting Seward, vessels docking at Anchorage must pass through the proposed sale area as well as the sealanes that may be used by those tankers serving the Nikiski complex. In 1991, 541 large vessels docked at the Port of Anchorage. Of this total, 319 were cargo vessels and 219 were deepwater freighters. Of the 514 dockings, 192 were barges (76 oil carriers) and 15 were petroleum tankers (Port of Anchorage, 1992).

Other large-ship destinations in the Cook Inlet are the Drift River Terminal, the Kenai/Nikiski area, and the deepwater-ballast anchorage in Kachemak Bay. The Drift River Terminal on the western side of Cook Inlet is served by a 40,000-deadweight ton tanker 29 times a year (Gduala, 1992, personal comm.). At the Nikiski complex, the Marathon LNG (liquified natural gas) plant is served by two 80,000-cubic meter LNG tankers. These vessels average an aggregate of 34 trips to Japan per year, moving a total of 1 million tons of LNG. The Tesoro Nikiski refinery also receives 10 to 14 shipments annually of crude oil from the Alyeska terminal in Valdez as well as various product carriers (USDOT, Maritime Administration, 1991). The Union Chemical dock at Nikiski loads three or more barges per month with urea for west coast markets (Stone, 1993, personal comm.). Excluding crude oil, some 1,000 million gallons of refined-petroleum product annually transit the Cook Inlet (Arthur D. Little, 1991).

While awaiting docking or a specified time of loading or unloading, tankers and barges often will drop anchor in Kachemak Bay. Periods of anchorage of up to 14 days have been observed; however, the anchorage time generally is <5 days, with usually no more than three vessels anchored in the bay (Stone, 1993, personal comm.). These vessels usually are in a ballast (noncargo) condition. This very deepwater bay from time to time has served as a demobilization point for exploration rigs. Because of the level of small-boat traffic and occasional large-vessel traffic, Kachemak Bay and its Port of Homer is served by a voluntary Vessel Traffic Separation System.

3. <u>High Case</u>: The high case features a range of resources that varies from 550 MMbbl produced over the 19-year life of the field to 1,100 MMbbl produced during the same period (Table II.A.1). This resource estimate ranges from four to five times that of the base case. The resource range is based on a range of

assumed values of produced crude oil. The value per barrel of oil assigned ranged from $18 to $30. Table II.A.1 displays the infrastructure and developmental timeframes proposed for the high case. The $12-difference in the price per barrel of oil between the high and low estimates of this case is equivalent to a twofold expansion in production and a two- to threefold expansion in related infrastructure.

Exploratory drilling activities are expected to occur in 1997 and 1999 (Table II.A.1). During this period, 8 to 20 exploration wells and 12 to 24 delineation wells are estimated to be drilled; 1 or 2 wells may be drilled at a time. The types of drilling units most likely to be used would be heavy-duty semisubmersibles or jackups. The most likely support base for exploration drilling activities would be Kenai, but alternative bases may be location elsewhere on the Kenai Peninsula.

Activities associated with development and production would begin in 2000 with the installation of a production platform (Table II.A.1); 8 to 20 platforms would be installed during a 3- to 6-year period between 2000 and 2006. The timing and level of production activities are based on an estimated crude-oil-production range of 550 to 1,100 MMbbl. The estimated level of activities associated with crude-oil production is based on this range; the low end of the activity range is associated with the 550-MMbbl estimate and the high end with 1,100 MMbbl. As noted above, the 550-MMbbl estimate is based on a barrel of crude oil selling for $18 and the 1,100-MMbbl estimate on oil selling for $30. Between 2000 and 2006, an estimated 122 to 360 production and service wells would be drilled using 1 to 7 drilling rigs. Crude-oil production is estimated to begin in 2003 and continue through 2021. Peak production is estimated to occur between 2004 and 2008; peak production would range from 46 to 92 MMbbl per year. Steel production platforms, similar to those used in upper Cook Inlet, may be the most likely type of platform used to develop and produce Sale 149 oil (Appendix A). Depending in part on site and environmental conditions, the size and shape of the field, and the oil reserves, other types of platforms that might be used in the Sale 149 include concrete gravity-based platforms similar to those installed in the North Sea or a semisubmersible floating production system with subsea wells. Support for development and production activities most likely would be from a shore base in the Kenai/Nikiski area.

Sale 149 oil most likely would be transported from the field(s) to the Nikiski industrial complex through approximately 150 to 200 mi of 12-in pipeline (Table II.A.1). Pipeline installation would occur between 2001 and 2002.

B. Alternative II, No Lease Sale:

1. **Description of the Alternative:** This alternative would be tantamount to cancellation of Sale 149. As a result of such a cancellation, the 100 to 300 MMbbl of oil estimated to be produced in the base-case scenario would be neither discovered nor developed. Should the sale not be held, the energy that would have flowed into the U.S. economy from resources leased under this sale would need to be provided by substitute sources.

Possible substitutes for the resources expected to be produced as a result of the proposed action include:

1. Oil supply substitutes
    - domestic onshore oil production
    - imported oil
2. Fuel substitutes in the transportation sector
    - imported methanol
    - gasohol
    - compressed natural gas
    - electric cars
3. Conservation
    - in the transportation sector
    - reduced consumption of plastics

In the case of the no-lease alternative, substitute energy flows probably would be provided by a mix of the substitutes listed above. The mix would depend on economic and regulatory factors as well as the short-run availability of capacity to produce and transport sufficient quantities of the various substitutes.

2. **Summary of Probable Effects**: The effects described for the base-case proposal (Sec. IV.B.1) would be eliminated by this alternative. However, cancellation of the sale would mean that the energy that would have flowed into the U.S. economy from resources leased under this sale would need to be provided by substitute sources. The energy probably would derive from a mix of sources. Each of these sources, with the possible exception of conservation measures, has negative environmental effects associated with its provision and use. Please refer to Appendix D for a more detailed discussion of alternative energy sources.

Cancellation of the lease sale also could mean that the quantities of North Slope oil currently transported by tanker from the TAPS terminal at Valdez to the refinery at Nikiski would continue at present or increasing levels. Production from proposed Sale 149 could back out some of the crude oil transported into Cook Inlet from Valdez and one of the results could be a reduction in tanker traffic transiting from Valdez to Cook Inlet along the eastern and southern coastlines of the Kenai Peninsula (Section IV.B.2).

C. **Alternative III, Delay the Sale (2 Years)**: This alternative would delay leasing of the proposed sale area for 2 years. The effects estimated to occur as a result of Alternative I would be delayed for 2 years.

D. **Alternative IV, Wildlife Concentration Deferral Alternative**: This alternative would offer for leasing 350 blocks (about 700,000 ha, or 1.74 million acres), approximately 88 percent of the area described for Alternative I. Areas offered by the proposal but not included in this alternative are located near Chisik and Duck Islands (Tuxedni Bay) and the Barren Islands (Fig. II.D.1). Chisik and Duck Islands are part of the Alaska Maritime National Wildlife Refuge and constitute the largest seabird colony in Cook Inlet.

For Alternative IV, the range of resources attributed to this alternative varies from a low of 80 MMbbl produced over the 19-year life of the field to a high of 240 MMbbl produced during the same period (Table II.A.1). The resource range is based on a range of assumed values of produced crude oil.

E. **Alternative V, Coastal Fisheries Deferral Alternative**: This alternative would offer for leasing 248 blocks (about 538,000 ha, or 1.33 million acres) located in the central part of the planning area in lower Cook Inlet (Fig. II.E.1). The area removed by the deferral alternative consists of 154 whole and partial blocks (about 262,000 ha or 647,000 acres), about 33 percent of the Alternative I area. The blocks proposed for deferral lie around the perimeter of much of the planning area in lower Cook Inlet where commercial-fishing activities occur. The perimeter area varies from one to six blocks wide (approximately 3-18 mi).

For Alternative V, the range of resources attributed to this alternative varies from a low of 70 MMbbl produced over the 19-year life of the field to a high of 210 MMbbl produced during the same period (Table II.A.1). The resource range is based on a range of assumed values of produced crude oil.

F. **Alternative VI, Pollock-Spawning Area Deferral Alternative**: This alternative would offer for leasing 360 blocks (about 723,000 ha, or 1.79 million acres) located in the lower Cook Inlet (Fig. II.F.1). The area removed by the deferral alternative consists of 42 whole and partial blocks (about 77,000 ha, or 190,000 acres), about 10 percent of the Alternative I area. The blocks proposed for deferral lie to the north and south of Cape Douglas at the entrance to Shelikof Strait. This alternative is intended to further protect pollock-spawning areas.

For Alternative VI, the range of resources attributed to this alternative varies from a low of 75 MMbbl produced over the 19-year life of the field to 225 MMbbl produced during the same period (Table II.A.1). The resource range is based on a range of assumed values of produced crude oil. For Alternative I (base case), this value per barrel ranged from $16 to $22.

The schedule of activities associated with this alternative is assumed to be the same as that predicted for Alternative I (base case) (Table II.A.1). The level of activities is based on an estimated range of resources, 75 to 225 MMbbl, which is less than that estimated for the Alternative I base case. The types of drilling units (jackups or semisubmersibles); production platforms (steel, concrete, or semisubmersible/subsea wells); and support-base location (Kenai/Nikiski area) would be the same as for Alterative I (base case).

G. **Alternative VII, General Fisheries Deferral Alternative**: This Alternative would offer for lease 216 blocks (about 426,000 ha, or 1.06 million acres) in the central lower Cook Inlet (Fig. II.G.1). This area

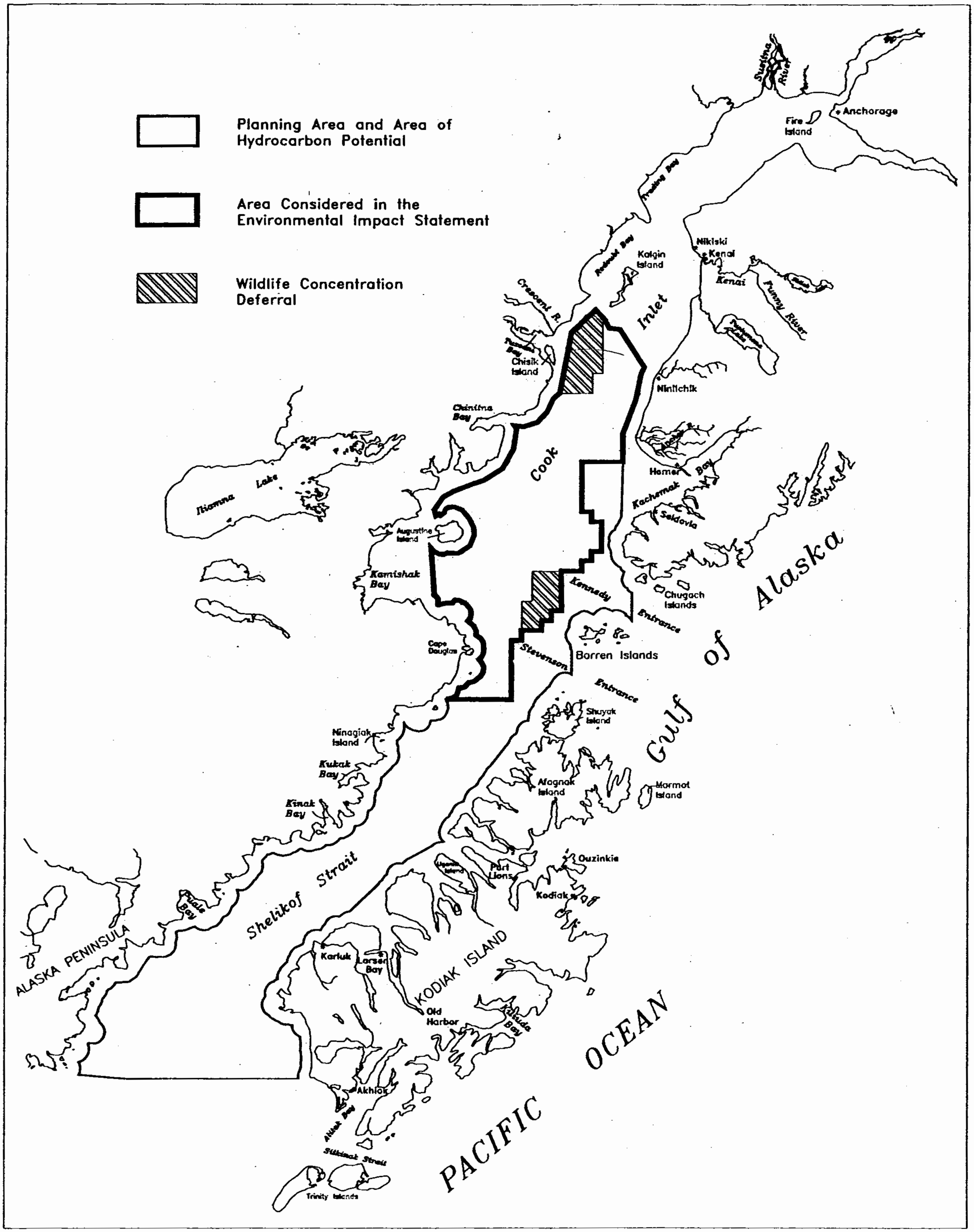


Figure II.D.1. Alternative IV. Wildlife Concentration Deferral Alternative.

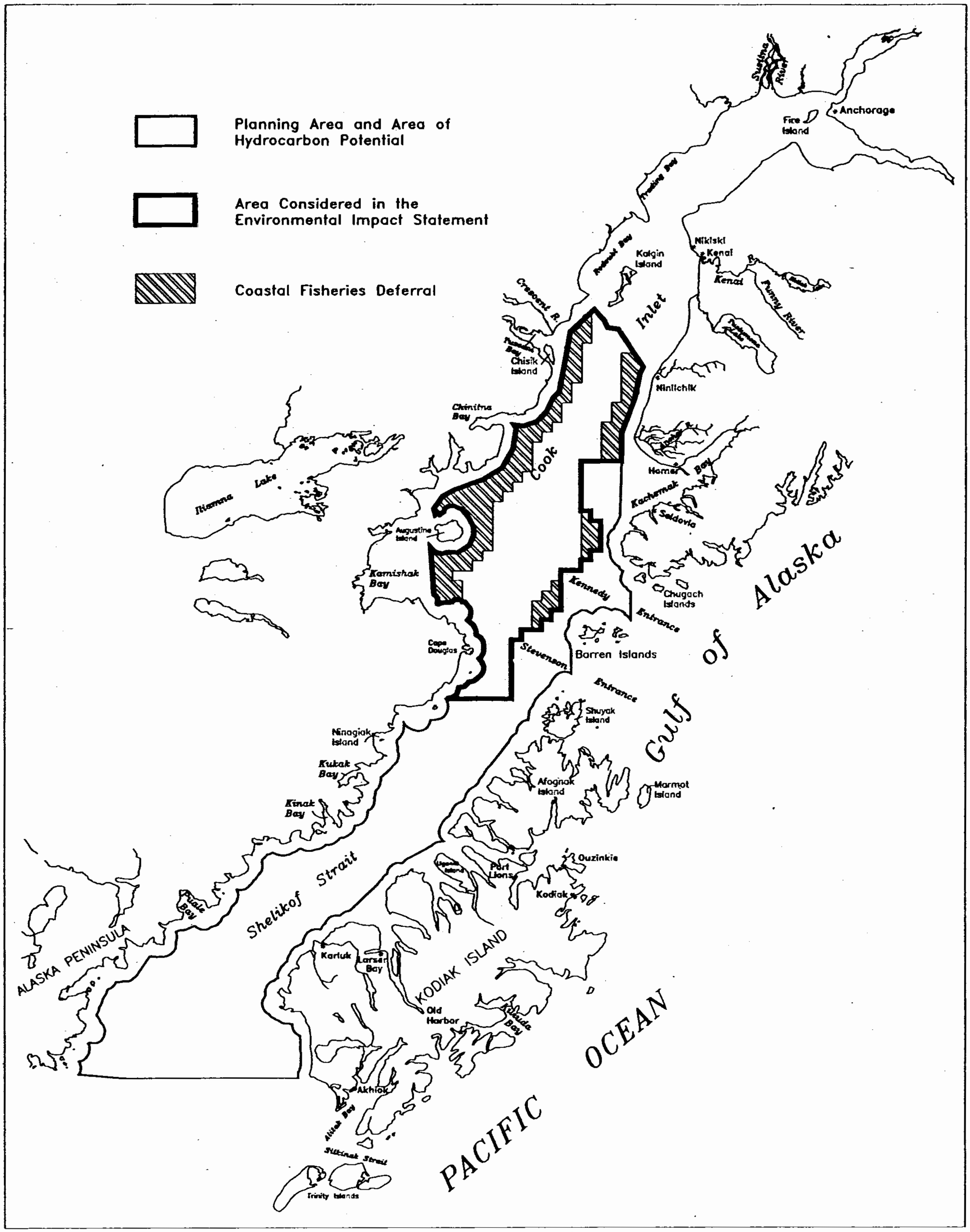


Figure II.E.1. Alternative V. Coastal Fisheries Deferral Alternative.

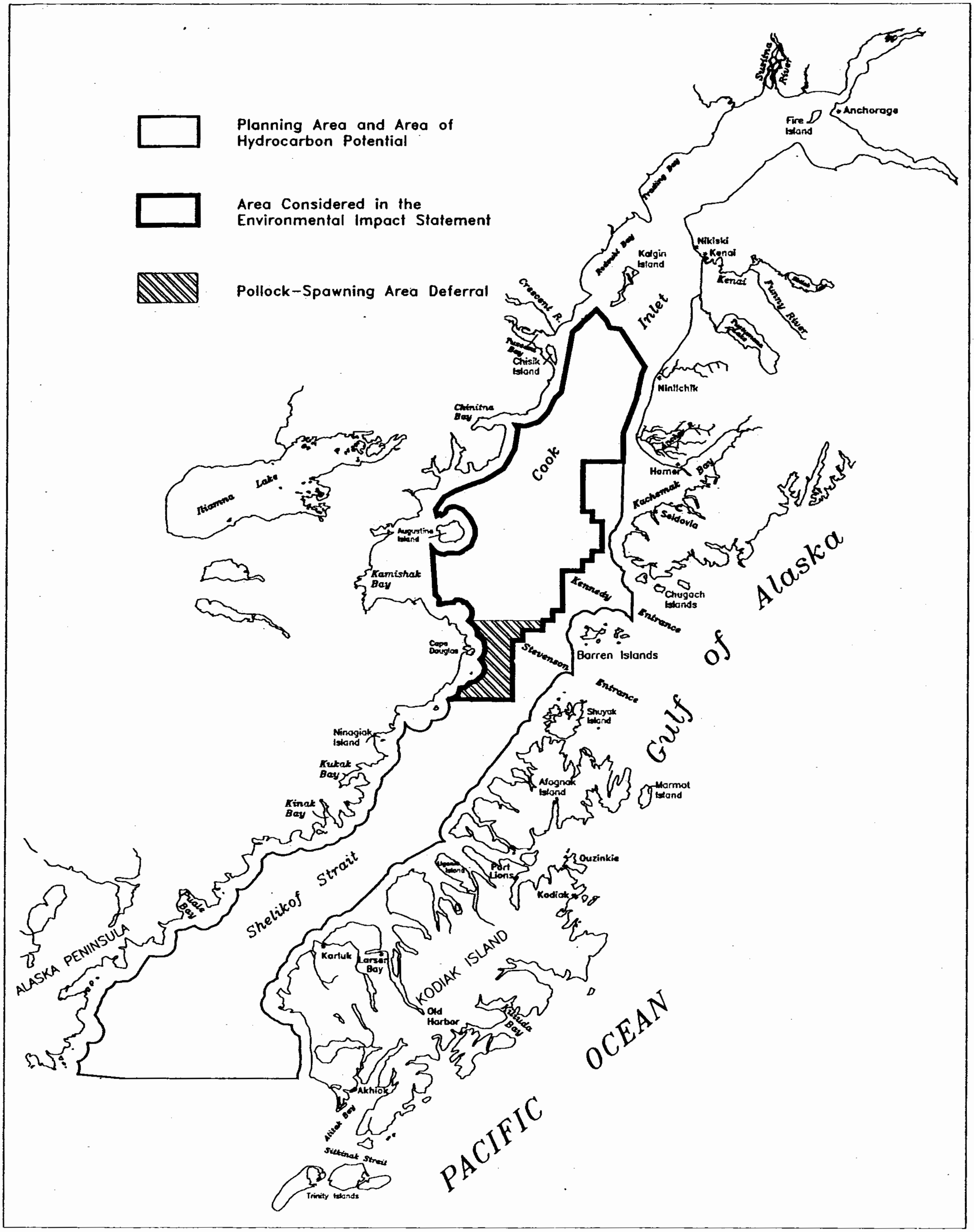


Figure II.F.1. Alternative VI. Pollock-Spawning Area Deferral Alternative.

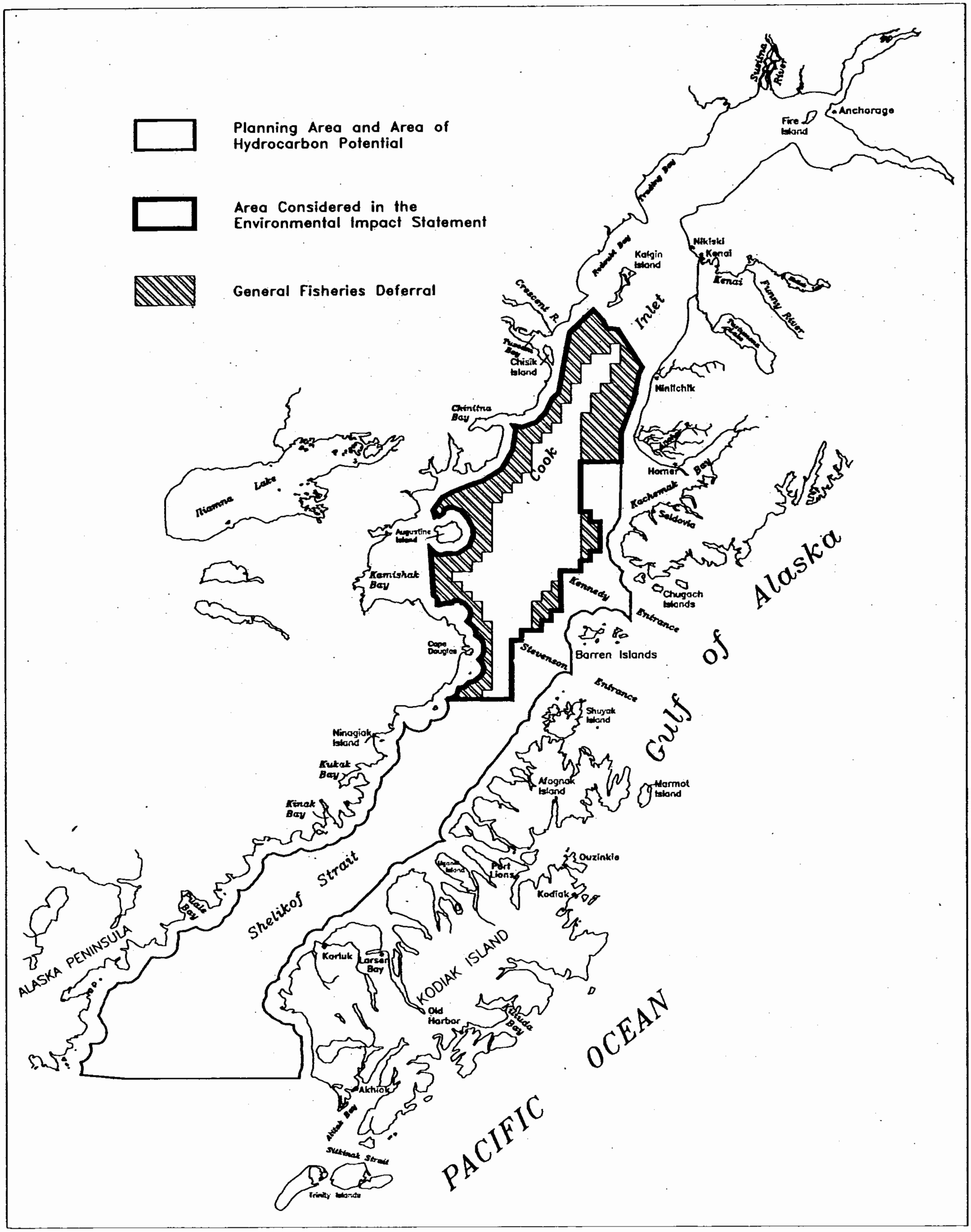


Figure II.G.1. Alternative VII. General Fisheries Deferral Alternative.

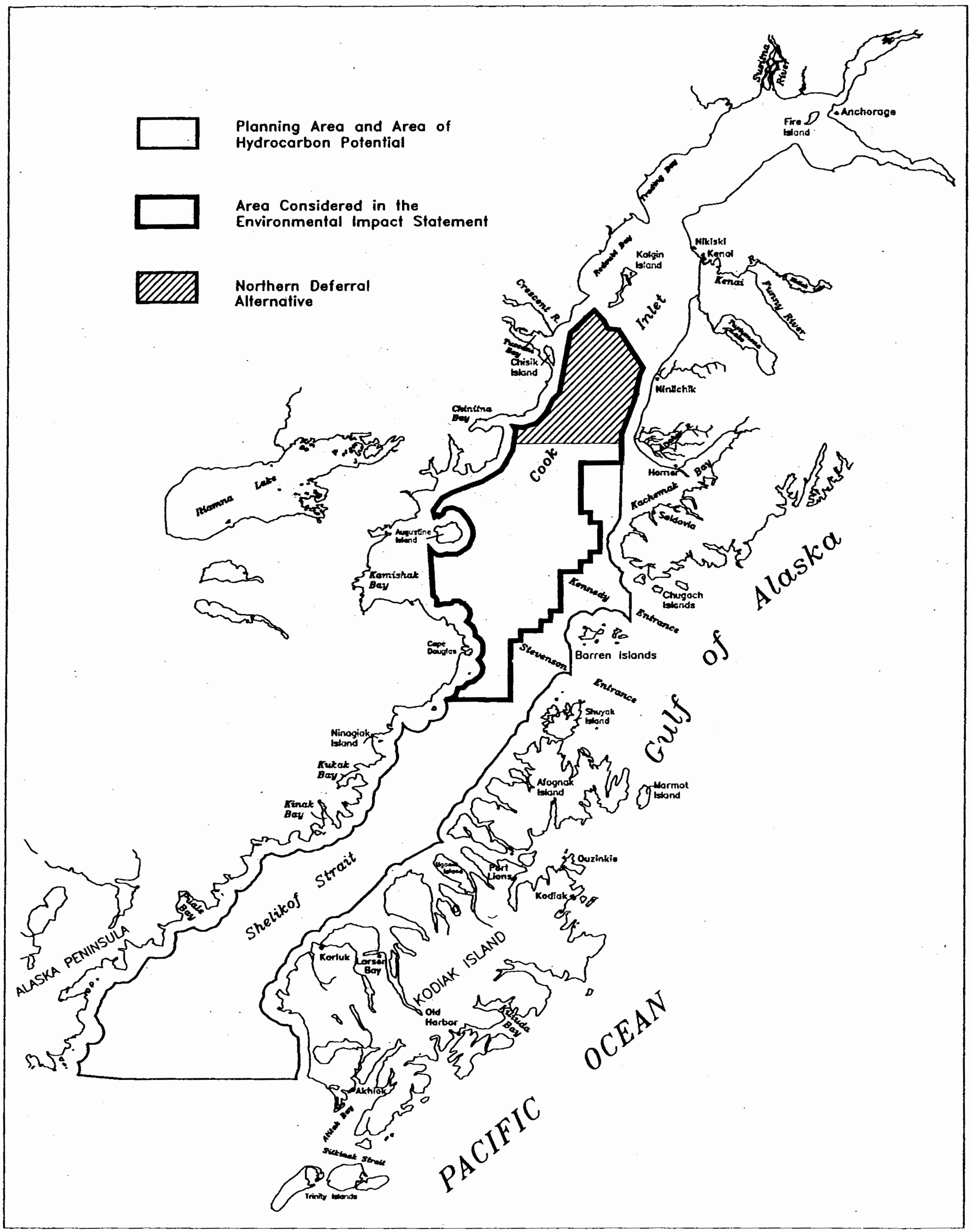


Figure II.H.1. Alternative VIII. Northern Deferral Alternative.

removed by the deferral alternative consists of 186 whole or partial blocks (about 371,000 ha, or 0.92 million acres), about 46 percent of the Alternative I area. The purpose of this alterative is to further protect the lower Cook Inlet fisheries areas. The amount of oil, 80 MMbbl, that might be discovered is not considered to be economically recoverable (Appendix A). Alternative VII is considered as an exploration-only scenario in which two wells are drilled within 3 years of the sale date.

H. <u>**Alternative VIII, Northern Deferral Alternative**</u>: This alternative would offer for lease 285 blocks (about 580,000 ha or 1.44 million acres) in that part of the Sale 149 area south of Anchor Point (Fig. II.H.1). The area removed by the deferral alternative consists of 117 whole or partial blocks (about 220,000 ha or 0.48 million acres), about 29 percent of the Alternative I area, located north of Anchor Point. Deletion of the blocks north of Anchor Point was proposed by the United Cook Inlet Drift Association during testimony at the Anchorage Public Hearing. As noted in the description of the Coastal Fisheries Deferral Alternative (Sec. I.D.2.a(2)), the area north of Anchor Point is the heart of the Cook Inlet salmon gillnet fishery. Deferral of these bocks would eliminate fishing-gear conflict between commercial-fishing activities and oil and gas operations in the OCS area north of Anchor Point. Also, there would be no discharges from drilling and production operations in the area. The blocks proposed for deletion from the sale area by this deferral alternative include some of the blocks proposed for deletion in Alternatives IV, V, and VII (Figs. II.D.1, II.E.1, and II.G.1, respectively).

For Alternative VIII, the range of resources attributed to this alternative varies from a low of 70 MMbbl produced over the 19-year life of the field to a high of 210 MMbbl produced during the same period (Table II.A.1). The resource range is based on a range of assumed values of produced crude oil. The schedule of activities associated with this alternative is assumed to be the same as that predicted for Alternative I (base case) (Table II.A.1). The level of petroleum industry activities would be less than that estimated for Alternative I (base case) (Table II.A.1).

I. <u>**Alternative IX, Kennedy Entrance Deferral Alternative**</u>: This alternative would offer for lease 385 blocks (about 760,000 ha or 1.88 million acres). The area removed by the deferral alternative consist of 17 blocks (about 40,000 ha or 0.10 million acres) in two areas adjacent to Kennedy Entrance (Fig. II.I.1). One of the areas is off the southwestern end of the Kenai Peninsula and the other is west of the Barren Islands. Deletion of the blocks near the western end of Kennedy Entrance was suggested by the State of Alaska. The deferral of northern blocks would reduce the risk of oil spills contacting subsistence-harvest areas used by the Native communities of Port Graham and Nanwalek, and the deferral of both areas would reduce potential conflicts with commercial fisheries. Both the northern set of blocks (located off the southwestern end of the Kenai Peninsula) and the southern set (located west of the Barren Islands) were part of Alternatives V and VII (Figs. II.E.1 and II.G.1, respectively), and the southern set of blocks also was part of Alternative IV (Fig. II.D.1).

For Alternative IX, the resources would range from a low of 100 MMbbl produced over the 19-year life of the field to a high of 300 MMbbl produced during the same period (Table II.A.1). The resource range is based on a range of assumed values of produced crude oil. The schedule of activities associated with this alternative is assumed to be the same as that predicted for Alternative I (base case) (Table II.A.1). The level of petroleum industry activities would be about the same as estimated for Alternative I (base case) (Table II.A.1).

J. <u>**Mitigating Measures**</u>: The Sale 149 mitigating measures are listed below and described in detail in Section II.J.1 and 2.

<u>**Sale 149 Mitigating Measures**</u>

<u>**Mitigating Measures that Are Part of the Proposed Action and Alternatives**</u>

<u>**Stipulations**</u>

- No. 1—Protection of Fisheries
- No. 2—Protection of Biological Resources
- No. 3—Orientation Program
- No. 4—Transportation of Hydrocarbons

<u>**Information to Lessees**</u>

- No. 1—Information on Bird and Marine Mammal Protection
- No. 2—Information on Sensitive Areas to be Considered in the Oil-Spill-Contingency Plans

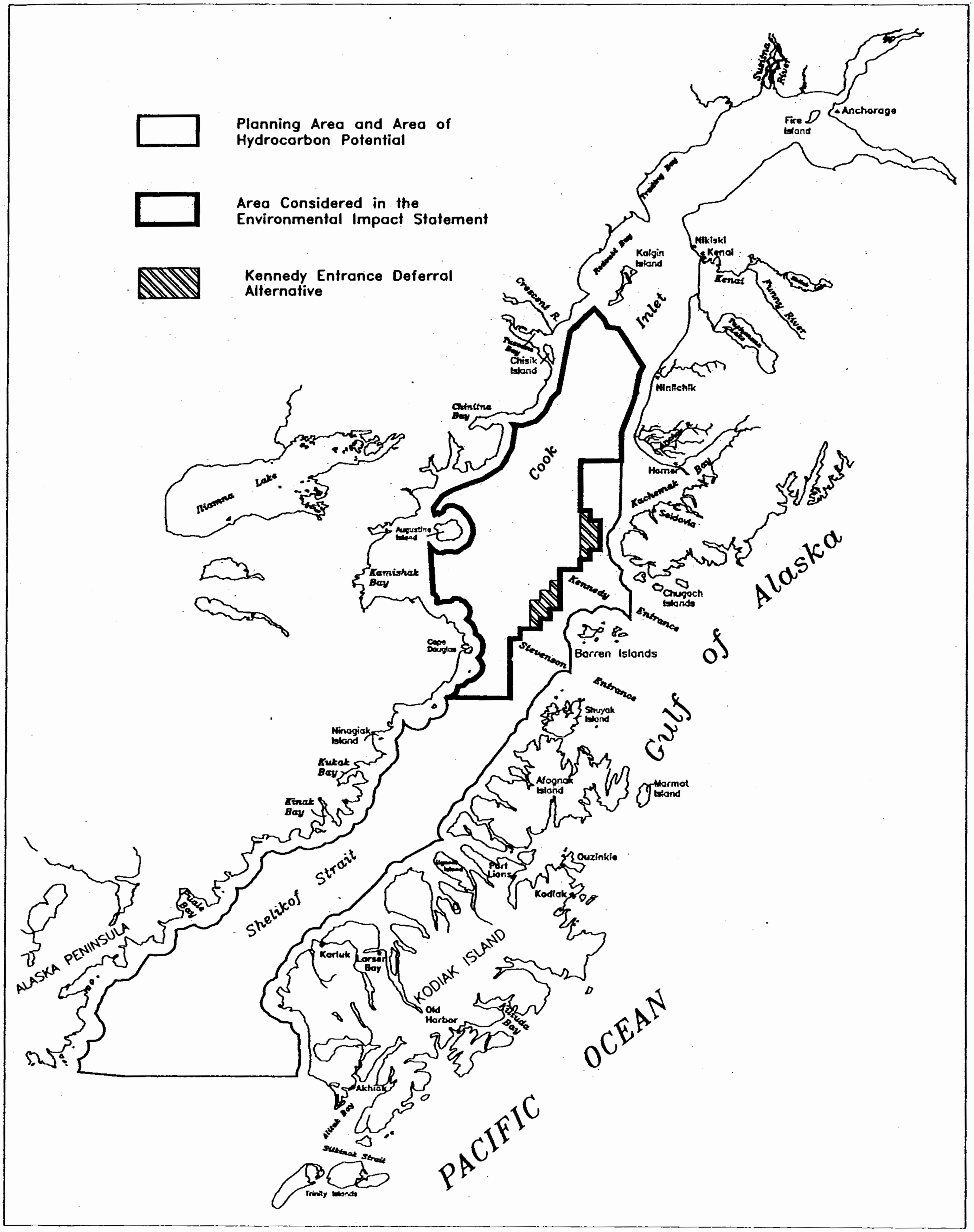


Figure II.I.1. Alternative IX. Kennedy Entrance Deferral Alternative.

No. 3—Information on Steller Sea Lion
No. 4—Information on Coastal Zone Management
No. 5—Information on Oil-Spill-Response Preparedness

Potential Mitigating Measures

Stipulations

No. 5—Restriction on Multiple Operations
No. 6—Seasonal Drilling Restriction
No. 7—No Surface Entry during Development and Production

Information to Lessees

No. 6—Information on Discharges into the Marine Environment
No. 7—Information on Community Monitoring of the Marine Environment

The mitigating measures considered as Information to Lessees (ITL's) either (1) state MMS policy and practices that are carried out and enforced, (2) inform lessees about special concerns in or near the lease area, or (3) advise or inform lessees of the existing legal requirements of MMS and other Federal agencies. These measures provide positive mitigation by creating greater awareness of these issues on the part of the lessees.

1. Mitigating Measures That Are Part of the Proposed Action and the Alternatives:

Laws and regulations that provide mitigation are considered part of the proposal. Examples include the Outer Continental Shelf Lands Act (OCSLA), which grants broad authority to the Secretary of the Interior to control lease operations and, where appropriate, undertake environmental monitoring studies (see Appendix E); the Consolidated Offshore Operating Regulations (which rescinded and replaced Alaska OCS Orders effective May 31, 1988); and the Fisherman's Contingency Fund. Incorporated by reference in Section I.C is OCS Report MMS 86-003, *Legal Mandates and Federal Regulatory Responsibilities* (Rathbun, 1986). Permit requirements, engineering criteria, testing procedures, and information requirements also are outlined. These requirements are developed and administered by the MMS. The mitigating effect of these measures has been factored into the environmental effects analysis.

A Protection of Archaeological Resources Stipulation was included in the draft EIS for Sale 149 but deleted from the final EIS. Since 1973, the U.S. Department of the Interior has included a stipulation on the OCS mineral-lease tract notifying potential lessees that, where applicable, archaeological resource surveys and reports will be required. In order to convert the requirements of the archaeological lease stipulation into regulations, a proposed rule was published by MMS on October 12, 1993 (58 *FR* 52731). The final rule amends the regulatory program of the MMS to state specifically the authority of MMS to require lessees or operators to conduct archaeological resource surveys and submit reports prior to exploration, development and production, or installation of right-of-way pipelines; the effective date of the rule is November 21, 1994 (59 *FR* 53091). Converting the requirements of the archaeological lease stipulation into regulations eliminates this stipulation from future MMS OCS leases and the need for a Secretarial decision on this mitigating measure.

In addition, the following mitigating measures (Stipulations and Information to Lessees Clauses) also are considered as part of the proposed action and alternatives. Accordingly, the mitigating effects of these measures also have been factored into the environmental effects analyses (Sec. IV).

a. Stipulations:

No. 1—Protection of Fisheries
No. 2—Protection of Biological Resources
No. 3—Orientation Program
No. 4—Transportation of Hydrocarbons

Stipulation No 1, Protection of Fisheries.

Exploration and development and production operations shall be conducted in a manner that prevents unreasonable conflicts between the natural gas and oil industry and fishing activities (including, but not limited to, subsistence and sport- and commercial-fishing activities).

Lease-related use will be restricted when the Regional Supervisor, Field Operations (RSFO), determines it is necessary to prevent unreasonable conflicts with local subsistence harvests and sport-and commercial-fishing operations. In enforcing this term, the RSFO will work with other agencies and the public to assure that potential conflicts are identified and efforts are taken to avoid these conflicts (for example, timing operations to avoid fishing activities, such as drift net fisheries that generally take place north of Anchor Point between June 25 and August 5, or locating structures away from major rip currents where there may be a higher density of fishing activity). In order to avoid these conflicts, restrictions, including directional drilling, seasonal drilling, subsea completion techniques and other technologies deemed appropriate by the RSFO may be required. This stipulation may be modified or waived if the RSFO, in consultation with the State of Alaska and the Kenai Peninsula Borough, determines that activities occurring during this time period will not result in unreasonable conflicts with fishing activities.

Prior to submitting an Exploration Plan (EP) or Development and Production Plan (DPP), as required by 30 CFR 250.33 (b) 14 and 17, and 250.34 (b)(8)(C)(v)(g) and (9), the lessee shall coordinate planned exploration and development activities, including plans for seismic surveys, drill rig transportation, or other vessel traffic, with fishermen operating in the area to prevent unreasonable fishing gear conflicts. In particular, the lessee shall discuss how mobilization of the drilling unit and crew and supply boat routes will be scheduled and located. The EP or DPP shall include a summary of fishing activities in the area of proposed operation, an assessment of effects on fishing from the proposed activity, and measures taken by the lessee resulting from coordinating with fishing interests to prevent unreasonable conflicts. This summary shall provide a method for notifying potentially affected fishing organizations, subsistence communities, and port authorities prior to commencement of proposed operations.

Local communities, including fishing interests, will have the opportunity to review and comment on proposed EP's and DPP's as part of the MMS regulatory review process pursuant to 30 CFR 250.33 and 34. During this review, fishing interests may comment on potential conflicts and the lessee's plans for preventing unreasonable conflicts. The comments will be considered during MMS's decision to approve, disapprove, or require modification of the plan.

Purpose of Stipulation No. 1: The interference addressed in this stipulation primarily is spatial; therefore, the purpose of this stipulation is to ensure that the petroleum industry and the participants in subsistence-, sport-, and commercial-fishing activities have a mechanism to ensure their activities are coordinated to minimize conflicts. Much of the Cook Inlet region has intensive commercial fishing for shellfish, groundfish, herring, and salmon during almost all periods of the year; although for the most part, these commercial fisheries do not operate concurrently. Some seasons also are very short term, e.g., herring. The fishing areas also are widespread from shoreline to far offshore. While widely distributed, some areas within this distribution have concentrated vessels and gear.

Subsistence fishing also occurs throughout Cook Inlet. Most of the households in the communities of Port Graham and Nanwalek participate in subsistence harvests. The harvests of fish in these communities and Tyonek ranges between 200 and 300 lb per capita. The harvestable resource include salmon, halibut, crab, and clams.

Sport fishing occurs throughout the sale area and in adjacent waters. This fishery includes fishing for salmon and halibut from both charter and private vessels, fishing from the shore, and harvesting of shellfish, such as clams and crabs.

Without safeguards, subsistence, sport, and commercial fishing may be subject to interference from offshore oil and gas operations.

Effectiveness of Stipulation No. 1: This stipulation will ensure early planning by the petroleum industry to prevent or reduce potential conflicts with subsistence, sport, and commercial fishing. This stipulation provides additional protection by advising lessees that exploration, development, and production activities should be conducted in a manner that minimizes any potential conflicts between the oil and gas industry and fishing activities. This measure will be especially useful in preventing interference with subsistence, sport, and commercial fishing from seismic surveys that could cause gear damage to or loss of fixed fishing gear.

Stipulation No. 2, Protection of Biological Resources.

If biological populations or habitats that may require additional protection are identified in the lease area by the Regional Supervisor, Field Operations (RS/FO), the RS/FO may require the lessee to conduct biological surveys to determine the extent and composition of such biological populations or habitats. The RS/FO shall give written notification to the lessee of the RS/FO's decision to require such surveys.

Based on any surveys which the RS/FO may require of the lessee or on other information available to the RS/FO on special biological resources, the RS/FO may require the lessee to:

(1) Relocate the site of operations;

(2) Establish to the satisfaction of the RS/FO, on the basis of a site-specific survey, either that such operations will not have a significant adverse effect upon the resource identified or that a special biological resource does not exist;

(3) Operate during those periods of time, as established by the RS/FO, that do not adversely affect the biological resources; and/or

(4) Modify operations to ensure that significant biological populations or habitats deserving protection are not adversely affected.

If any area of biological significance should be discovered during the conduct of any operations on the lease, the lessee shall immediately report such findings to the RS/FO and make every reasonable effort to preserve and protect the biological resource from damage until the RS/FO has given the lessee direction with respect to its protection.

The lessee shall submit all data obtained in the course of biological surveys to the RS/FO with the locational information for drilling or other activity. The lessee may take no action that might affect the biological populations or habitats surveyed until the RS/FO provides written directions to the lessee with regard to permissible actions.

Purpose of Stipulation No. 2: Important biological populations and habitats in addition to those already identified in the Information to Lessees on Areas of Special Biological and Cultural Sensitivity may exist in the proposed sale area. Such populations and habitats may require additional protection. If critical biological resources are identified, measures could be developed to reduce possible adverse effects on them from oil and gas activities. These measures could include shifts in operational sites, modifications in drilling procedures, and increased consideration of the areas during oil-spill-contingency planning.

Effectiveness of Stipulation No. 2: This stipulation provides a formal mechanism for identifying important or unique biological populations or habitats that require additional protection because of their sensitivity and/or vulnerability. If these populations or habitats are found to exist in the lease area, the stipulation provides a means for developing measures to reduce possible adverse effects from oil and gas activities. For example: Katmai Bay and Katmai National Park, brown bears and birds; Maritime National Wildlife Refuge, seabirds; Tuxedni Bay and Chignik and Duck Islands, seabirds; Maritime National Wildlife Refuge and Kachemak Bay, waterfowl and fisheries; and Barren Islands Maritime National Wildlife Refuge, seabirds.

Through identification of biological populations or habitats requiring special protection, this stipulation also could provide data for the environmental report required for exploration and development plans that must be reviewed and approved according to 30 CFR 250.33 and 250.34. Stipulation No. 2 is not likely to change the overall effect levels of the proposal on biological resources, although local reductions in effects on habitat or effects on specific, vulnerable populations may occur.

Stipulation No. 3, Orientation Program.

The lessee shall include in any exploration or development and production plans submitted under 30 CFR 250.33 and 250.34 a proposed orientation program for all personnel involved in exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) for review and approval by the Regional Supervisor, Field Operations. The program shall be designed in sufficient detail to inform individuals working on the project of specific types of environmental, social, and cultural concerns that relate to the sale and adjacent areas. The program shall address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals and provide guidance on how to avoid disturbance. The program shall be designed to increase the sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which such personnel will be operating. The orientation program also shall include information concerning avoidance of conflicts with subsistence, commercial-fishing activities, and pertinent mitigation.

The program shall be attended at least once a year by all personnel involved in onsite exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) and all supervisory and managerial personnel involved in lease activities of the lessee and its agents, contractors, and subcontractors.

The lessee shall maintain a record of all personnel who attend the program onsite for so long as the site is active, not to exceed 5 years. This record shall include the name and date(s) of attendance of each attendee.

<u>**Purpose of Stipulation No. 3**</u>: The purpose of this stipulation, which addresses the concern of residents expressed during the scoping process for this and for other Alaska sales, is to provide increased protection to the environment. The orientation program would promote an understanding of, and appreciation for, local community values, customs, and lifestyles of Alaskans without creating undue costs to the lessee. It also would provide necessary information to industry personnel about the biological resources used for commercial and subsistence activities, about archaeological resources of the area and appropriate ways to protect them from adverse effects, and about the concerns for reducing industrial noise and disturbance effects on marine mammals and marine and coastal birds.

<u>**Effectiveness of Stipulation No. 3**</u>: This measure provides positive mitigating effects, because it would make all personnel involved in petroleum-industry activities aware of the unique environmental, social, and cultural values of local residents and their environment. There is concern that uninformed workers and subcontractors unknowingly could destroy or damage the biological environment, be insensitive to local historical or cultural values, or unnecessarily disrupt the local economy. This stipulation also would minimize conflicts between subsistence-hunting activities and activities of the oil and gas industry. Overall, the Orientation Program stipulation would reduce effects somewhat but not enough to change the levels of effects identified for the proposal.

<u>Stipulation No. 4, Transportation of Hydrocarbons</u>.

Pipelines will be required: (a) if pipeline rights-of-way can be determined and obtained; (b) if laying such pipelines is technologically feasible and environmentally preferable; and (c) if, in the opinion of the lessor, pipelines can be laid without net social loss, taking into account any incremental costs of pipelines over alternative methods of transportation and any incremental benefits in the form of increased environmental protection or reduced multiple-use conflicts. The lessor specifically reserves the right to require that any pipeline used for transporting production to shore be placed in certain designated management areas. In selecting the means of transportation, consideration will be given to any recommendation of Federal, State, and local governments and industry.

Following the development of sufficient pipeline capacity, no crude oil production will be transported by surface vessel from offshore production sites, except in the case of emergency. Determinations as to emergency conditions and appropriate responses to these conditions will be made by the Regional Supervisor, Field Operations.

<u>**Purpose of Stipulation No. 4**</u>: This stipulation provides a formal way of selecting a means of transporting petroleum from a sale area. It also informs the lessee that (1) MMS reserves the right to require the placement of pipelines in certain designated management areas, (2) pipelines must be designed and constructed to withstand the hazardous conditions that may be encountered in the sale area, and (3) pipeline construction and associated activities be in compliance with 30 CFR 250.150-164 et seq. and that any construction of gas pipeline be in compliance with 49 CFR 191-195 et seq.

Under the provisions of 30 CFR 250.150-164, the RS/FO may suspend pipeline operations upon a determination that continued activity would threaten or cause serious irreparable or immediate harm or damage to aquatic life, personal property, or the marine coastal or human environment. The RS/FO also may suspend pipeline operations or right-of way grants if the RS/FO has determined that the lessee, or right-of-way holder has failed to comply with a provision of the OCSLA or any other applicable law, a provision of other applicable regulations, or a condition or permit of right-of-way grants. In considering an application for a pipeline right-of-way, the RS/FO shall consider the potential effect of the pipeline on human, marine, and coastal environments and shall prepare an environmental analysis of such an action. As part of this environmental analysis, the RS/FO will consider the views of appropriate Federal, State, and local government agencies as well as private organizations, industry, and individuals.

This stipulation is intended to ensure that the decision on which method to use in transporting hydrocarbons considers the social, environmental, and economic consequences of pipelines.

Note: The Alaska Regional Technical Working Group has been discontinued. This was done in response to President Clinton's Executive Order 12838, which directed the Department of the Interior and other Federal agencies to reduce the number of advisory committees. However, the MMS will continue to work with the State, appropriate local government organizations, and other groups with an interest in the OCS program.

Effectiveness of Stipulation No. 4: The analysis of the effects of the Sale 149 proposal on the physical, biological, and socioeconomic resources of the sale and adjacent areas considers pipelines as the method of transporting produced oil in the sale area. Because of this, Stipulation No. 4 is not expected to significantly reduce the overall effects levels identified for the resources analyzed in Section IV. However, implementation of this stipulation reinforces the preferences of coastal districts for pipelines to carry produced oil to shore for onshore storage and transhipment. The implementation of this stipulation also will tend to ensure that environmental and economic issues receive balanced consideration during the process in which the means and methods of transporting produced crude oil are selected.

b. Information to Lessees (ITL's):

No. 1—Information on Bird and Marine Mammal Protection
No. 2—Information on Sensitive Areas to be Considered in the Oil-Spill-Contingency Plans
No. 3—Information on Steller Sea Lion
No. 4—Information on Coastal Zone Management
No. 5—Information on Oil-Spill-Response Preparedness

ITL No. 1, Information on Bird and Marine Mammal Protection.

Lessees are advised that during the conduct of all activities related to leases issued as a result of this sale, the lessee and its agents, contractors, and subcontractors will be subject to the following laws; among others, the provisions of the Marine Mammal Protection Act (MMPA) of 1972, as amended (16 U.S.C. 1361 et seq.); the Endangered Species Act (ESA), as amended (16 U.S.C. 1531 et seq.); and applicable International Treaties.

Lessees and their contractors should be aware that disturbance of wildlife could be determined to constitute harm or harassment and thereby be in violation of existing laws and treaties. With respect to endangered species and marine mammals, disturbance could be determined to constitute a "taking" situation. Under the ESA, the term "take" is defined to mean "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or to attempt to engage in such conduct." Under the MMPA, "take" means "harass, hunt, capture, collect, or kill or attempt to harass, hunt, capture, or kill any marine mammal." Violations under these Acts and applicable Treaties must be reported to the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (FWS), as appropriate.

Incidental taking of marine mammals and endangered and threatened species is allowed only when the statutory requirements of the MMPA and/or the ESA are met. Section 101(a)(5) of the MMPA allows for the taking of small numbers of marine mammals incidental to a specified activity within a specified geographical area. Section 7(b)(4) of the ESA allows for the incidental taking of endangered and threatened species under certain circumstances. If a marine mammal species is listed as endangered or threatened under the ESA, the requirements of both the MMPA and the ESA must be met before the incidental take can be allowed.

Under the MMPA, the NMFS is responsible for species of the order Cetacea (whales and dolphins) and the suborder Pinnipedia (seals and sea lions) except walrus; the FWS is responsible in Alaskan waters for polar bears, sea otters, and walrus. Procedural regulations implementing the provisions of the MMPA are found at 50 CFR Part 18.27 for FWS, and at 50 CFR Part 228 for NMFS.

Lessees are advised that specific regulations must be applied for and in place and the Letters of Authorization must be obtained by those proposing the activity to allow the incidental take of marine mammals whether or not they are endangered or threatened. The regulatory process may require 1 year, or longer.

Of particular concern is disturbance at major wildlife concentration areas, including bird colonies, marine mammal haulout and breeding areas, and wildlife refuges and parks. Maps depicting major wildlife concentration areas in the lease area are available from the Regional Supervisor, Field Operations. Lessees also are encouraged to confer with the FWS and NMFS in planning transportation routes between support bases and lease holdings.

Lessees should exercise particular caution when operating in the vicinity of species whose populations are known or thought to be declining and that are not protected under the ESA; specifically, Steller's eiders, spectacled eiders, marbled murrelet, Pacific harbor seals, and northern fur seals.

Behavioral disturbance of most birds and mammals found in or near the lease area would be unlikely if aircraft and vessels maintain at least a 1-mi horizontal distance and aircraft maintain at least a 1,500-ft vertical distance above known or observed wildlife concentration areas, such as bird colonies and marine mammal haulout and breeding areas.

For the protection of endangered whales and marine mammals throughout the lease area, it is recommended that all aircraft operators maintain a minimum 1,500-ft altitude when in transit between support bases and exploration sites. Lessees and their contractors are encouraged to minimize or reroute trips to and from the leasehold by aircraft and vessels when endangered whales are likely to be in the area. Human safety should take precedence at all times over these recommendations.

Purpose of ITL No. 1: The purpose of this measure is to minimize behavioral disturbances of wildlife, particularly at known concentration areas. The Cook Inlet/Shelikof Strait region is important habitat for endangered and nonendangered marine mammals, marine birds, and waterfowl.

Effectiveness of ITL No. 1: Although advisory, it is expected that this measure will help reduce the unforeseen disturbance of wildlife by alerting lessees to (1) the provisions of those acts and treaties protecting marine mammals, endangered species, and birds; (2) the recommended distance/altitude to allow between aircraft or vessels and wildlife concentrations to prevent most disturbance; and (3) the locations of major-wildlife concentration areas. In addition, the measures encourage lessees to confer with the appropriate wildlife-protection agencies regarding procedures that could be used to avoid disturbing wildlife—especially during aircraft and vessel operations. Because of the uncertainties that often accompany the movements of animals and of humans and their vehicles, some interactions between marine mammals and birds and lease exploration, development, or production activities, especially involving aircraft and vessel operations, are likely to occur.

Due to the advisory nature of this measure and the characteristics of the aircraft and vessel controls, it is likely that some marine mammals and birds would interact with the activity associated with platforms and all attendant exploration, development, and production traffic over the life of the field (19 years). It cannot be assumed that unforeseen conflict can be completely avoided or that incidental "taking" would not occur.

ITL No. 2, Information on Sensitive Areas to be Considered in the Oil-Spill-Contingency Plans (OSCP).

Lessees are advised that environmentally sensitive areas are valuable for their concentrations of marine birds, marine mammals, fishes, pollock-spawing habitats, or other biological resources or cultural resources and should be considered when developing OSCP's. Identified areas of special biological and cultural sensitivity include:

Chisik and Duck Islands, Kamishak Bay, Kachemak Bay, the Barren Islands, Marmot Island, Tugidak Island, Chirikof Island, Puale Bay, and the Pye Islands all contain or are inhabited in whole or part by concentrations of biological resources that should be considered.

In addition, five National Wildlife Refuges (Alaska Maritime, Alaska Peninsula, Becharof, Kenai, Kodiak); Lake Clark National Park and Preserve; Aniakchak National Monument and Preserve; all Islands classified as wilderness under the authority of Katmai National Park and Preserve; McNeil River State Game Sanctuary; State Game Refuges (Trading Bay and McNeil River); Critical Habitat Areas (Kalgin Island, Clam Gulch, Fox River Flats, Kachemak Bay, Tugidak Island, and Redoubt Bay), Alaska State Parks (Shuyak, Afognak Island, Kachemak Bay, and Kachemak Bay Wilderness Park); and the Captain Cook State Recreation Area are located near or adjacent to the Cook Inlet Planning Area and also include important concentrations of biological resources which should be considered in developing the OSCP. These areas are managed by the U.S. Fish and Wildlife Service (FWS), National Park Service (NPS), and State of Alaska, respectively.

The National Historic Landmarks (Yukon Island Main site near Homer) have been identified as sensitive and should also be considered.

Industry should consult with FWS, NPS, or State personnel to identify specific environmentally sensitive areas within national wildlife refuges, national park system units, or State special areas that should be considered when developing a project-specific OSCP.

These locations are among areas of special biological and cultural sensitivity to be considered in the OSCP required by 30 CFR 250.42. Lessees are advised that they have the primary responsibility for identifying these areas in their OSCP's and for providing specific protective measures. Additional areas of special biological and cultural sensitivity may be identified during review of exploration plans and development and production plans.

Consideration should be given in OSCP's as to whether use of dispersants is an appropriate defense in the vicinity of an area of special biological and cultural sensitivity. Lessees are advised that prior approval must be obtained before dispersants are used.

Purpose of ITL No. 2: The purpose of this ITL is to help protect environmentally sensitive areas and their concentrations of marine birds, marine mammals, fishes, and other biological resources and cultural resources from oil spills by providing consideration in developing OSCP's and identifying areas of special biological and cultural sensitivity. These include: Katmai Bay, Katmai National Park, Puale Bay, Maritime National Wildlife Refuge, Tuxedni Bay, Chisik and Duck Islands, Maritime National Wildlife Refuge, and Kachemak Bay.

Effectiveness of ITL No. 2: Consideration in OSCP's of the identified areas of special biological sensitivity could help protect these as well as other areas from oil spills. Protection of special biological areas would reduce the effects on the biological resources of the areas. This measure provides some protection for marine and coastal birds, fisheries, and biologically sensitive habitats that are listed in the ITL (Chisik and Duck Islands, Kamishak Bay, Barren Islands, Marmot Island, Tugidak Island, Chirikof Island, Puale Bay, Kachemak Bay, Kupreanof Strait, and Pye Islands). The lessees are informed that these areas should be protected in case of an oil spill.

ITL No. 3, Information on Steller Sea Lion.

Lessees are advised that the Steller sea lion is listed as a threatened species by the U.S. Department of Commerce and is protected by the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.). Lessees should conduct their activities in a manner that will limit potential encounters and interactions between lease operations and Steller sea lions. The National Marine Fisheries Service (NMFS) is responsible for the protection of Steller sea lions, and lessees are advised to contact NMFS regarding proposed operations and actions that might be taken to minimize interaction with Steller sea lions and known haulout and pupping areas.

Lessees are advised that the Steller sea lion has been listed as threatened under the Endangered Species Act with protective regulations (55 *FR* 12645, April 5, 1990).

Purpose of ITL No. 3: The purpose of this ITL is to inform lessees that the Steller sea lion, protected under the MMPA since 1972, also is protected under the ESA wherein, for example, implications of incidental take, critical habitat designation, and Section 7 consultation are discussed.

Effectiveness of ITL No. 3: Protection of the Steller sea lion will be enhanced if lessees conduct activities in a manner that avoids the types of interactions that are discussed in the ESA; lessees informed of the specific types of interactions to be avoided will be less likely to violate provisions of the act.

ITL No. 4, Information on Coastal Zone Management.

Lessees are advised that the Alaska Coastal Management Program (ACMP) may contain policies and standards that are relevant to exploration and development and production activities associated with leases resulting from this sale.

In addition, coastal districts including the Kodiak Island Borough, Kenai Peninsula Borough, Matanuska-Susitna Borough, and the Municipality of Anchorage, have enforceable policies that have been incorporated into the ACMP. These policies are more specific than the Statewide standards.

Relevant policies are applicable to ACMP consistency reviews of postlease activities. Lessees are encouraged to consult and coordinate early with those involved in coastal management review.

Purpose of ITL No. 4: The purpose of this ITL is to inform lessees of relevant policy areas contained in the ACMP and to alert lessees to the fact that the State reviews exploration plans and development and production plans, including the siting of energy-related facilities, for consistency with these policies. Furthermore, it informs the lessee of local coastal management programs that may have policies supplementing the Statewide standards of the ACMP.

Effectiveness of ITL No. 4: This ITL could help to reduce potential conflicts with both land use regulations and coastal management policies by alerting lessees that Alaska has an approved CMP that is amended by the borough programs. Policies included in the ACMP are designed to prevent or mitigate environmental and social problems that may be associated with development. Although the application of ACMP policies is not expected to modify the levels of effect that result from accidental oil spills, conformance with these standards and policies would help to alleviate some potential adverse effects, especially those identified for subsistence. Moreover, the process of achieving consensus and obtaining final approval of projects could be substantially eased and potential conflicts with the ACMP reduced if lessees coordinate early with those involved in coastal management reviews.

ITL No.5, Information on Oil-Spill-Response Preparedness.

Lessees are advised that they must be prepared to respond to oil spills which could occur as a result of offshore natural gas and oil exploration and development activities. With or prior to submitting a plan of exploration or a development and production plan, the lessee will submit for approval an oil-spill-contingency plan (OSCP) in accordance with 30 CFR 250.42 and 30 CFR 254. Of particular concern are sections of the OSCP which address potential spill size and trajectory, specific actions to be taken in the event of a spill, the location and appropriateness of oil-spill equipment, and the ability of the lessee to protect communities and important resources from adverse effects of a spill. In addition, lessees will be required to conduct spill response drills which include deployment of equipment to demonstrate response preparedness for spills under realistic conditions. Guidelines for oil spill contingency planning and response drills which supplement 30 CFR 250.43 and 30 CFR 254 have been developed and are available from the Regional Supervisor/Field Operations.

Purpose of ITL No. 5: The purpose of this ITL is to ensure lessees are (1) ready to respond to a platform oil spill that might occur as a result of their operations and (2) have the appropriate equipment and trained personnel available to conduct cleanup operations. Response readiness is addressed in the OSCP's that are submitted to MMS for approval and demonstrated, to a limited extent, by oil-spill-response drills conducted under appropriate environmental conditions.

Effectiveness of ITL No. 5: The requirements of this ITL reiterate the oil-spill-response preparedness requirements contained in 30 CFR 250.42, OSCP's, and 250.43, Training and Drills. Lessee are required to submit OSCP's for MMS approval either with or prior to submitting Exploration Plans or Development and Production Plans; approved OSCP's are to be reviewed and updated annually.

To ensure a prompt response in the event of a platform oil spill, OSCP's must address items such as (1) various spill-response strategies; (2) types, capabilities, and local and regional inventories of various types of response equipment, material, and supplies; and (3) training of personnel, including conducting drills. (The drills are to be realistic and include the deployment of equipment.) Knowledge of the response strategies and training personnel in the use of response equipment ensure a more rapid and efficient response to an oil spill.

Response strategies are based in part on the source of the spilled oil and the anticipated size of the spill. The flow rate of oil from OCS wells ranges from 10 to more than 8,000 bbl per day (bbl/day)—the average flow rate is about 180 bbl/day. The flow rates for Sale 149 wells are estimated to range from 410 to 1,780 bbl/day. The average flow rate for Sale 149 wells is estimated to be 1,150 bbl/day. The flow rate is based upon 20 production wells; the production platforms also have 6 service wells. Thus, strategies to clean up crude oil from a well blowout might be based on volumes of 1,000 to 5,000 bbl/day. In contrast, tanker spills sometimes involve the release of large volumes of oil in a relatively short time. As a result of the grounding of the *Exxon Valdez*, about 250,000 bbl of oil were released into the waters of Prince William Sound within several hours.

The procedures taken in advance to respond to a platform oil spill help provide for a more effective response. However, as noted in Section IV.A.4, the effectiveness of oil-spill cleanup at sea is quite variable and depends on sea slate, weather, and ice conditions; (2) time of response; (3) type of cleanup procedure used; and (4) type of oil spilled. With so many variables, recovery of most of the spilled oil is unlikely.

As noted in Section II.H., laws and regulations that provide mitigation are considered part of the proposed lease sale; the mitigating effects of these laws and regulations are considered in the analyses of the effects of Sale 149 (Sec. IV). Thus, adoption of the ITL would not be expected to significantly reduce the effects on any of the resources that might be affected by a platform or other type of oil spill.

The MMS responsibilities for operations on the OCS are directed toward ensuring operational safety and preventing pollution, with major emphasis on prevention. To this end, MMS inspects all OCS exploratory drilling operations throughout the year on a near-continuous basis to ensure compliance with stringent safety and pollution-prevention regulations.

2. **Potential Mitigating Measures**: The following mitigating measures are offered as information and/or to reduce or eliminate potential adverse effects identified in Section IV. A Secretarial/ Assistant Secretarial decision on these mitigating measures has not occurred; they are noted here as potential measures that could further mitigate the effects of this proposed lease sale. The Secretary/Assistant Secretary has imposed similar measures in previous Federal oil and gas lease sales; use of these measures is likely to continue unless more effective mitigating measures are identified. If any of these measures are adopted, they will appear in the Notice of Sale. The analysis in this EIS does not assume that the following mitigating measures are in place; however, they are evaluated in the discussions of the effectiveness of information to lessees that follow each of the potential measures.

a. Stipulations:

No. 5—Restriction on Multiple Operations
No. 6—Seasonal Drilling Restriction
No. 7—No Surface Entry during Development and Production

Stipulation No. 5, Restriction on Multiple Operations:

In the event that two or more simultaneous drilling operations are proposed, an analysis of use conflicts will be conducted to ensure that unreasonable conflicts with fishing activities do not occur.

The MMS will prepare an environmental analysis on each proposed exploration (EP) or development and production (DPP) plan in accordance with 30 CFR 250.33 and 34. Local communities, including fishing interests, will have the opportunity to review and comment on proposed EP's and DPP's as part of the MMS regulatory review process pursuant to 30 CFR 250.33 and 34. This assessment, which will take into consideration the time, location, and nature of the operation, will evaluate the cumulative effects from proposed multiple operations on the OCS and adjacent State submerged lands. The spatial proximity between multiple drilling operations and the type and location of fishing activities and other vessel traffic that might occur during the proposed drilling period and the methods for avoiding potential conflicts which are developed as a result of consultations required by the Protection of Fisheries stipulation, will be considered in the assessment.

Purpose of Stipulation No. 5: The purpose of Stipulation No. 5 is to reduce space-use conflicts between exploratory drilling operations and commercial-fishing activities that might be operating in same areas. Such conflicts could cause inefficient use of fishing gear or their fouling in facilities or equipment associated with exploratory drilling.

Effectiveness of Stipulation No. 5: Stipulation No. 5 could be used to reduce the number of exploratory drilling units operating in areas used in the commercial fisheries. By limiting the number of exploratory drilling that could operate in commercial fishing areas, the potential for conflicts between oil and gas exploratory drilling operations and commercial fishing activities would be reduced.

Stipulation No. 6, Seasonal Drilling Restriction.

This stipulation applies only to the following blocks: Official Protraction Diagram (OPD) NP 05-08, blocks 7013-7015; 7063-7065; 7113-7114 and OPD NO 05-02, blocks 6013-6014; 6063-6064; 6112-6114; 6162-6163; 6211-6213; 6261-6263; 6311-6313; and 6361-6363.

Exploratory drilling on this block will be prohibited from June 15 through August 15 to reduce conflicts with fishing activities. This stipulation may be modified or waived if the Regional Supervisor, Field Operations, in consultation with the State of Alaska and the Kenai Peninsula Borough, determines that activities occurring during this time period will not create conflicts with commercial fishing.

Purpose of Stipulation No. 6: The purpose of Stipulation No. 6 is to reduce space-use conflicts between exploratory drilling operations and commercial-fishing activities that might be operating in same areas. Such conflicts could cause inefficient use of fishing gear or their fouling in facilities or equipment associated with exploratory drilling.

Effectiveness of Stipulation No. 6: Stipulation No. 6 would eliminate exploratory drilling units from operating in areas used in the commercial fisheries during the specified time period. (The area affected by the proposed seasonal drilling restriction is located along the northeastern perimeter of the sale area; it consists of a corridor that is about 6 miles wide and extents from about 9 miles south of Anchor Point to about 6 miles north of Ninilchik.) By eliminating exploration drilling activities, conflicts between oil and gas exploratory drilling operations and commercial fishing activities would be eliminated during the specified time period.

Stipulation No. 7 No Surface Entry during Development and Production.

This stipulation applies only to the following blocks: Official Protraction Diagram (OPD) NP 05-08, blocks 7013-7015; 7063-7065; 7113-7114 and OPD NO 05-02, blocks 6013-6014; 6063-6064; 6112-6114; 6162-6163; 6211-6213; 6261-6263; 6311-6313; and 6361-6363.

Surface entry onto this block will be restricted or may be prohibited during oil and gas production and development. Access to oil and gas resources on this block is allowable by directional drilling or by other methods which preclude conflicts with fisheries activities. This stipulation may be modified or waived if the Regional Supervisor, Field Operations, in consultation with the State of Alaska and the Kenai Peninsula Borough, determines that the location or design of these facilities will not create conflicts with commercial fishing.

Purpose of Stipulation No. 7: Stipulation No. 7 could be used to reduce the number of blocks where surface entry to oil and gas resources is allowed in the commercial fisheries.

Effectiveness of Stipulation No. 7: Stipulation No. 7 could be used to reduce the number of surface entries to access oil and gas resources. By limiting the number of surface entries in commercial fishing areas, the potential for conflicts between oil and gas development and production operations and commercial-fishing activities would be reduced; prohibiting surface entry could eliminate conflicts.

b. Information to Lessees:

No. 6—Information on Discharges into the Marine Environment
No. 7—Information on Community Monitoring of the Marine Environment

ITL No. 6, Information on Discharges into the Marine Environment.

Lessees are advised that discharges into marine waters are prohibited unless authorized by the U.S. Environmental Protection Agency (USEPA) approved National Pollutant Discharge Elimination System (NPDES) permit in accordance with the Clean Water Act. By agreement between the Department of the Interior (USDOI) and the USEPA, the Minerals Management Service (MMS) will conduct NPDES permit compliance inspections in conjunction with its inspections of postlease operations authorized under the Outer Continental Shelf Lands Act.

Through the cooperative agreement between USDOI and USEPA, the lease sale Environmental Impact Statement provides a thorough description and analysis of water quality and biological resources in the sale area. This information will be used by the USEPA in its process for setting discharge restrictions during its NPDES permit review process.

In accordance with 30 CFR 250.40 (b), the MMS may restrict the rate of drilling fluid discharges or prescribe alternative methods of discharge. The MMS may also restrict the use of components which could cause unreasonable degradation of the marine environment. Lessees are also advised that the method of disposal of drill cuttings, sand, and other well solids shall be approved by the MMS.

Purpose of ITL No. 6: The purpose of this ITL is to help minimize the potential effects of discharges into the marine environment from those activities associated with petroleum exploration and development and production and to inform lessees that MMS will conduct NPDES permit compliance inspections. The agreement between the USDOI and the EPA, whereby the MMS will conduct NPDES permit-compliance inspections in conjunction with its inspections of postlease operations authorized under the OCSLA, is noted in Appendix K.

Effectiveness of ITL No. 6: The effectiveness is based on the positive benefit that comes with creating a greater awareness of those issues addressed by the ITL. This ITL provides the lease operators with a notice of special concerns regarding discharges into the marine environment. In addition, MMS inspects all OCS oil and gas operations for compliance with stringent safety and pollution-prevention regulations. (In the Alaska OCS Region, MMS inspectors are at exploration-drilling sites during all drilling operations.) The presence of the MMS inspectors will help ensure compliance with the requirements of the NPDES permit and timely warnings to MMS and EPA of potential problems associated with any discharges.

ITL No. 7, Information on Community Monitoring of the Marine Environment.

Lessees are advised observation groups may be formed in many small communities to monitor the shores adjacent to the lease area before and after lease-related activities occur. Communities who are dependent on marine resources have indicated that they plan to monitor the status of the water, shoreline, and associated living resources and report results to Minerals Management Service (MMS). The MMS will consider this information when reviewing lessees' activities.

Purpose of ITL No. 7: The purpose of this ITL is to notify lessees that residents intend to monitor the marine environment near any OCS-related activity and to document changes that they discern; this information will be used when reviewing lessees' activities. Residents are acutely aware of the environment in the vicinity of their community and plan to monitor on a continuous basis. Using this process, residents can be involved in an ongoing activity to ensure that chronic as well as special-cause effects are identified quickly. The MMS commitment to use this information when reviewing lessees' activities provides residents with an avenue for continuing input into the postlease process.

Effectiveness of ITL No. 7: This ITL effectively involves residents in a long-term relationship with MMS. It does not require this involvement, but provides it for those residents who wish to participate. By providing this measure of involvement, residents are assured that the sale can proceed without passing them by. Another benefit is that detrimental effects, including low-level-chronic effects to the shore, can be identified quickly and activities can be adjusted appropriately.

K. **Summaries and Comparisons of Effects for the Alternatives and the Cumulative Case for the Cook Inlet Planning Area Sale 149:** Table II.K.1 presents the summaries and comparisons of potential effects for Alternatives I, IV, V, VI, VII, VIII, and IX and the cumulative case. The comprehensive analyses of the potential effects of Sale 149 are presented in Section IV.B; it is particularly important to refer to these analyses rather than use only this summary table as the indicator of potential effects.

Table II.K-1

Summaries and Comparisons of Effects for Alternatives and the Cumulative Case for the Cook Inlet Planning Area Oil and Gas Lease Sale 149

Water Quality
Lower Trophic-Level Organisms
Fisheries Resources

Marine and Coastal Birds
Nonendangered Marine Mammals

Endangered and Threatened Species
Terrestrial Mammals

Economy
Commercial Fisheries
Subsistence-Harvest Patterns

Sociocultural Systems
Archaeological and Cultural Resources
National and State Parks and Related Areas
Air Quality

Coastal Zone Management

The summaries presented in this table are based on the comprehensive analyses in Section IV.B.

Summary of Sale 149 Oil-Spill Assumptions (small and large spills). For Sale 149 analysis, oil spills are categorized as small (<1,000 bbl) and large (≥1,000 bbl). Small spills consist of (1) >1 but <50 bbl and (2) ≥50 but <1,000 bbl; the average size of these spills is 5 and 160 bbl, respectively. It is assumed that small spill will occur during oil production (the estimated numbers of small spills and volumes for each of the alternatives are given in Table IV.A.2). For Alternative I (base case) the Oil-Spill-Risk Analysis (OSRA) estimates a mean number of 0.31 spills ≥1,000 bbl are likely to occur with an estimated 27-percent chance of one or more such spills occurring. The OSRA estimates a mean number of 0.26, 0.21, 0.23, 0.21, and 0.31 spills ≥1,000 bbl are likely to occur with an estimated 23-, 19-, 21,- 19-, and 27-percent of one or more such spill occurring for Alternatives IV, V, VI, VIII, and IX, respectively. Alternative VII assumes only exploratory drilling activities would take place; if oil is discovered the quantity is estimated to be too small to be produced and no ≥1,000-bbl spills would occur. For the cumulative case, the OSRA estimates a mean number of spills ≥1,000-bbl of 1.01 with an estimated 64 percent chance of one or mores such spills occurring.

WATER QUALITY

Alternative I (Base Case):	Alterative IV (Wildlife Concentration Deferral Alternative)	Alternative V (Coastal Fisheries Deferral Alternative)	Alternative VI (Pollock-Spawning Area Deferral Alternative)
Water quality would be reduced from good (unpolluted) to polluted by the presence of hydrocarbons from one or more large (≥1,000-bbl) accidental oil spills that have a relatively low chance (27%) of occurring. Hydrocarbon levels >15 μg/l (Alaska chronic criterion for protection of marine life) would be temporary (1-<2 months) and affect an area of several thousand square kilometers.	Effects are expected to be the same as the Alternative I (base case), except there would be no direct exploration or production discharges in the deferred areas (about 12% of the Alternative I area) and there would be a 3- to 20-percent reduction in the discharges. The chance of one or more large spills occurring is 23 percent.	Effects are expected to be the same as the Alternative I (base case), except there would be no direct exploration or production discharges in the deferred areas (about 33% of the Alternative I area) and there would be a 30- to 40-percent reduction in the discharges. The chance of one or more large spills occurring is 19 percent.	Effects are expected to be the same as the Alternative I (base case), except there would be no direct exploration or production discharges in the deferred areas (about 10% of the Alternative I area) and there would be a 4- to 25-percent reduction in the discharges. The chances of one or more large spills occurring is 21 percent.

LOWER TROPHIC-LEVEL ORGANISMS

Alternative I (Base Case)	Alterative IV (Wildlife Concentration Deferral Alternative)	Alternative V (Coastal Fisheries Deferral Alternative)	Alternative VI (Pollock-Spawning Area Deferral Alternative)
In lower Cook Inlet, a large (≥1,000-bbl) oil spill would have sublethal to lethal effects on an estimated (1) 1 to 5 percent of the phytoplankton and zooplankton populations in the open-water areas, (2) 2 percent of the plankton in embayments, (3) 20 to 30 percent of the intertidal and shallow subtidal marine invertebrates, and (4) <5 percent of the subtidal benthic populations. Recovery times are expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton in open-water areas, 1 to 2 weeks for plankton in embayments, and 2 to 3 years for marine invertebrates in high energy environments and 7 years in low energy environments.	Effects are expected to be similar to the Alterative I (base case).	Effects are expected to be similar to the Alterative I (base case).	Effects are expected to be similar to the Alternative I (base case).

FISHERIES RESOURCES

Alternative I (Base Case)	Alterative IV (Wildlife Concentration Deferral Alternative)	Alternative V (Coastal Fisheries Deferral Alternative)	Alternative VI (Pollock-Spawning Area Deferral Alternative)
Assuming contact (when combined probability of >5% to contact specific land or resource segments), the overall estimated effects of an assumed large (≥1,000-bbl) spill on fisheries resources are expected to be minimal, with the possible loss of some adult demersal fishes and possible increased mortality of eggs and larvae of pink salmon and semidemersal and demersal fishes; there is a 27-percent chance that one or more spills ≥1,000 bbl could occur. The various effects to fisheries resources taken altogether are not expected to cause population-level changes.	Effects are expected to be the same as the Alternative I (base case).	Effects are expected to be the same as the Alternative I (base case).	Similar to Alterative I, changes in population levels are not expected. The reduced potential of an oil spill decreases the potential effects (lethal) to the eggs and larvae of pollock in Shelikof Strait and of other demersal fishes in the sale area. Fisheries resources around the Barren Islands, Shuyak Island, and Cape Douglas also are afforded some additional protection.

WATER QUALITY

Alternative VII (General Fisheries Deferral Alternative--Exploration Only)	Alternative VIII (Northern Deferral Alternative)	Alternative IX (Kennedy Entrance Deferral Alternative)	Cumulative Case
The overall quality of Cook Inlet water would remain good (unpolluted). There would be no direct exploration discharges in the deferred areas (about 46% of the Alternative I area) and a 90- to 100-percent reduction in the discharges compared to Alternative I (base case).	Effects are expected to be the same as the Alternative I (base case), except there would be no direct exploration or production discharges in the deferred areas (about 28% of the Alternative I area) and there would be a 30- to 40-percent reduction in the discharges. The chance of one or more large spills occurring is 19 percent.	Effects are expected to be the same as the Alternative I (base case), except there would be no direct exploration or production discharges in the deferred areas (about 5% of the Alternative I area). The chance of one or more large spills occurring is 27 percent.	The permitted, routine discharges associated with municipal wastewaters, seafood processing, and oil and gas development and small (<1,000-bbl) oil spills are not expected to cause any measurable degradation of Cook Inlet water quality. Water quality would be reduced from good (unpolluted) to polluted by the presence of hydrocarbons from one or more large (≥1,000-bbl) oil spills that have a 64-percent chance of occurring; one spill is assumed from Sale 149 Alternative I (base case) production and the other from offshore State production. Contamination from each spill (the presence of hydrocarbons in amounts >15 μg/l) would be temporary (last for a month, or more) and affect an area of several thousand square kilometers.

LOWER TROPHIC-LEVEL ORGANISMS

Alternative VII (General Fisheries Deferral Alternative--Exploration Only)	Alternative VIII (Northern Deferral Alternative)	Alternative IX (Kennedy Entrance Deferral Alternative)	Cumulative Case
Routine activities associated with Alternative VII are estimated to have mostly sublethal effects on about half of the lower trophic-level organisms estimated for the base case (<1% of those in the sale area). The recovery of benthic organisms from drilling discharges is expected within 1 year after they cease.	Effects are expected to be similar to the Alternative I (base case).	Effects are expected to be similar to Alternative I (base case).	Each of the two large spills is estimated to have lethal and sublethal effects on (1) 1 to 5 percent of the plankton, (2) about 20 to 30 percent of the intertidal and shallow subtidal marine invertebrates, and (3) <5 percent of the subtidal benthic populations. After each spill, recovery times are expected to take 1 or 2 days for phytoplankton, up to 2 weeks for zooplankton, 2 to 3 years for marine invertebrates in high-energy environments, and up to 7 years for marine invertebrates in lower energy environments.

FISHERIES RESOURCES

Alternative VII (General Fisheries Deferral Alternative--Exploration Only)	Alternative VIII (Northern Deferral Alternative)	Alternative IX (Kennedy Entrance Deferral Alternative)	Cumulative Case
Effects on finfish populations are expected to be minimal. Effects on demersal fishes very likely would be limited to only the short time periods when materials are being discharged.	Effects are expected to be the same as the Alternative I (base case).	Effects are expected to be the same as the Alternative I (base case).	The overall cumulative effect on fisheries resources may include reduced stocks of some fisheries resources (sockeye, coho, and chinook salmon and some semidemersal fishes such as pollock) due to commercial fishing and other activities. This effect could persist for several generations or longer. The contribution of the proposal to the cumulative case is expected to be minimal with no population-level effects.

MARINE AND COASTAL BIRDS

Alternative I (Base Case)	Alterative IV (Wildlife Concentration Deferral Alternative)	Alternative V (Coastal Fisheries Deferral Alternative)	Alternative VI (Pollock-Spawning Area Deferral Alternative)
The effects of a 50,000-bbl-oil spill assuming most likely contact (when ≥5%) to bird habitats are expected to include the loss of up to 100,000 birds with recovery taking more than one generation (probably <3 generations or <15 years); the chance of one or more large (≥1,000-bbl) oil spills occurring is estimated to be 27 percent. Sea ducks and shorebirds are expected to suffer reduced productivity in areas where intertidal-habitat contamination from the spill persists for a number of years, with this local effect expected to last for >1 year to perhaps several years.	The overall effects are expected to be the same as the Alternative I (base case). This alternative could provide localized reduction in potential platform oil-spill effects to seabirds nesting in Tuxedni Bay (Cassock/Duck Islands) and, to a lesser extent, the Barren Islands and other marine and coastal bird habitats areas.	The overall effects are expected to be the same as the Alternative I (base case). Oil-spill effects on bird populations could be potentially reduced locally in the Kamishak, Tuxedni, Chinitna, and Kachemak Bays.	The overall effects are expected to be about the same as the Alternative I (base case). Oil-spill effects on bird populations could be reduced locally in the Cape Douglas area, nearshore habitats on the western side of Afognak and Shuyak Islands, and in Kamishak and Kachemak Bays to a limited extent due to less oil being transported in the lease area.

NONENDANGERED MARINE MAMMALS (PINNIPEDS, CETACEANS, AND THE SEA OTTER)

Alternative I (Base Case)	Alterative IV (Wildlife Concentration Deferral Alternative)	Alternative V (Coastal Fisheries Deferral Alternative)	Alternative VI (Pollock-Spawning Area Deferral Alternative)
A large (50,000-bbl) spill), assuming contact with marine mammals, would have measurable (numbers of individuals) lethal effects on fur seals (<10), harbor seals (63), killer whales (<5), beluga whales (43), and sea otters (75-100); the chance of one or more large (≥1,000 bbl) oil spills occurring is estimated to be 27 percent. Fur and harbor seal mortalities are not expected to have population level effects. Recovery to pre-spill numbers for killer whales is expected to take 1 to 2 years, beluga whales 7 years, and sea otters 1-2 years. Noise, disturbance, and habitat alteration activities would be relatively short term and very localized and should not affect marine mammal survival.	Effects from oil spill contact are the same as the base case with a potential mortality of <10 fur seals and killer whales, respectively: approximately 40 beluga whales and 60 harbor seals; and between 75 to 100 sea otters. Recovery to prespill numbers for fur seals, killer whales, and sea otters is estimated to occur in about 1 to 2 years; for belgua whales recovery is estimated to take 7 years. Potential habitat alteration and noise and disturbance effects to these marine mammals due to exploration and production in these buffer areas also would be eliminated.	Effects from oil spill contact are the same as the base case with a potential mortality of <10 fur seals and killer whales, respectively: approximately 40 beluga whales and 60 harbor seals; and between 75 to 100 sea otters. Recovery to prespill numbers for fur seals, killer whales, and sea otters is estimated to occur in about 1 to 2 years; for belgua whales recovery is estimated to take 7 years. Potential habitat alteration and noise and disturbance effects to these marine mammals due to exploration and production in these buffer areas also would be eliminated.	Effects from oil spill contact are the same as the base case with a potential mortality of <10 fur seals and killer whales, respectively: approximately 40 beluga whales and 60 harbor seals; and between 75 to 100 sea otters. Recovery to prespill numbers for fur seals, killer whales, and sea otters is estimated to occur in about 1 to 2 years; for belgua whales recovery is estimated to take 7 years. Potential habitat alteration and noise and disturbance effects to these marine mammals due to exploration and production in these buffer areas also would be eliminated.

MARINE AND COASTAL BIRDS

Alternative VII (General Fisheries Deferral Alternative–Exploration Only)	Alternative VIII (Northern Deferral Alternative)	Alternative IX (Kennedy Entrance Deferral Alternative)	Cumulative Case
This alternative is expected to greatly reduce the effects of the Alternative I (base case). Overall effects are expected to include the loss of very small numbers of birds or their eggs (such as fewer than 100 individuals), with recovery occurring within less than one generation, and no population effects on marine and coastal birds are expected to occur.	The overall effects are expected to be the same as the Alternative I (base case). Oil-spill effects on bird populations potentially could be slightly reduced locally in the Tuxedni, Chinitna, Kachemak and Kamishak Bays, and in the Katmai area and the Portlock Bank habitat.	The overall effects are expected to be the same as the Alternative I (base case). Oil-spill effects from production platforms on bird populations potentially could be reduced locally on the Barren Islands, and Kachemak Bay.	The overall effects on marine and coastal birds are expected to involve the loss of tens of thousands of birds and the loss of thousands of acres of old-growth-forest habitat of some species (murrelets). This effect is expected to persist for more than one to several generations. The contribution of the Alternative I (base case) is expected to include <50 percent of the mortality and <1 percent of the habitat loss.

NONENDANGERED MARINE MAMMALS (PINNIPEDS, CETACEANS, AND THE SEA OTTER)

Alternative VII (General Fisheries Deferral Alternative–Exploration Only)	Alternative VIII (Northern Deferral Alternative)	Alternative IX (Kennedy Entrance Deferral Alternative)	Cumulative Case
There would be no oil-spill-associated mortality under this deferral alternative. Seismic noise associated with exploration is expected to have minimal effects on nonendangered marine mammals. Overflight-disturbance reactions probably would be short term, with seals reoccupying haulouts and whales continuing their activities usually within a matter of hours. Disturbance from habitat alteration or construction activities would be relatively short term and very localized and should not affect marine mammal survival.	Effects from oil spill contact are the same as the base case with a potential mortality of <10 fur seals and killer whales, respectively: approximately 40 beluga whales and 60 harbor seals; and between 75 to 100 sea otters. Recovery to prespill numbers for fur seals, killer whales, and sea otters is estimated to occur in about 1 to 2 years; for belgua whales recovery is estimated to take 7 years. Potential habitat alteration and noise and disturbance effects to these marine mammals due to exploration and production in these buffer areas also would be eliminated.	Effects from oil spill contact are the same as the base case with a potential mortality of <10 fur seals and killer whales, respectively: approximately 40 beluga whales and 60 harbor seals; and between 75 to 100 sea otters. Recovery to prespill numbers for fur seals, killer whales, and sea otters is estimated to occur in about 1 to 2 years; for belgua whales recovery is estimated to take 7 years. Potential habitat alteration and noise and disturbance effects to these marine mammals due to exploration and production in these buffer areas also would be eliminated.	The overall cumulative effect on nonendangered marine mammals over the 19-year life of the proposal may include fairly large mortalities of harbor seals, primarily due to commercial fishing activities. This effect could persist for several generations or longer. Mortalities to other marine mammals is expected to have minimal population level effects. The contribution of the proposal to the cumulative case is expected to be minimal with no population level effects.

ENDANGERED AND THREATENED SPECIES

Alternative I (Base Case)	Alterative IV (Wildlife Concentration Deferral Alternative)	Alternative V (Coastal Fisheries Deferral Alternative)	Alternative VI (Pollock-Spawning Area Deferral Alternative)
Effects of disturbance and drilling discharges on endangered whales and the Steller sea lion are expected to be minimal. A large (≥1,000-bbl) oil spill (assuming most likely spill contact to habitats with combined probability ≥5%) is not expected to cause whale mortality, but the regional sea lion population is expected to require at least one generation for recovery from contact. No adverse effects are expected on short-tailed albatross, Aleutian Canada goose, or peregrine falcon populations. Wintering Steller's eiders are expected to require up to two generations for recovery from oil spill contact. Effects of a large oil spill on endangered species is expected to be minimal with a few species requiring up to 2 generations for recovery from contact; the southern marbled murrelet population may require up to 8 generations.	Overall effects are expected to be essentially as determined for Alternative I (base case)——effects on endangerd whales nonlethal, Steller sea lion losses requiring at least 1 generation for recovery, Steller's eider losses requiring 2 generations for recovery. This alternative could provide limited local reduction of oil spill effects in the Barren Islands.	Overall effects are expected to be slightly less than determined for Alternative I (base case)——effects on endangered whales nonlethal, Steller sea lion losses requiring at least 1 generation for recovery, Steller's eider losses requiring 2 generations for recovery. This alternative could provide limited local reduction of oil spill effects in southeastern lower Cook Inlet and the Barren Islands	Overall effects are expected to be somewhat less than determined for Alternative I (base case)--effects on endangered whales nonlethal, Steller sea lion losses requiring at least 1 generation for recovery, Steller's eider losses requiring 2 generations for recovery. This alternative could provide limited local reduction of oil spill effects in the Barren/Shuyak Islands area and northern Shelikof Strait.

TERRESTRIAL MAMMALS

Alternative I (Base Case)	Alternative IV (Wildlife Concentration Deferral Alternative)	Alternative V (Coastal Fisheries Deferral Alternative)	Alternative VI (Pollock-Spawning Area Deferral Alternative)
Overall effects on terrestrial mammals are expected to include the loss of small numbers of river otters (<50), brown bears (<10), and Sitka black-tailed deer (<100) directly killed by the assumed 50,000 bbl oil spill and assuming contact (>1%, combined probabilities) to specific coastline habitats. Total recovery of river otters and perhaps brown bears and their habitats is expected to take >1 year (perhaps 3 years), while the potential loss of Sitka black-tailed deer is expected to be replaced within 1 year. Regional populations of brown bears, river otters, black-tailed deer, and other terrestrial mammals are not expected to be affected by the oil spill or by the exploration and development activities.	Effects are expected to be about the same as the Alternative I (base case). Potential oil-spill effects could be reduced locally in the Tuxedni and Chinitna Bays area, Alaska Peninsula, and Kachemak Bay from a potential platform spill; but a potential pipeline or tanker spill still would pose some chance of contact to terrestrial mammals at these and other coastal habitats.	Effects are expected to be about the same as the Alternative I (base case). Oil-spill effects on brown bears, river otters, and other terrestrial mammals are expected be reduced locally along the coast of Hallo, Iniskin, Chinitna, and Tuxedni Bays; the Nikishka area south to Kachemak Bay on the Kenai Peninsula.	Effects are expected to be about the same as the Alternative I (base case). Oil-spill effects on brown bears, river otters, and other terrestrial mammals are expected to be reduced locally along the coastline of Hallo Bay and Cape Douglas and, to a lesser extent, along the coast of Afognak and Shuyak Islands.

ENDANGERED AND THREATENED SPECIES

Alternative VII (General Fisheries Deferral Alternative–Exploration Only)	Alternative VIII (Northern Deferral Alternative)	Alternative IX (Kennedy Entrance Deferral Alternative)	Cumulative Case
Because the potential risk from oil spills would be eliminated this alternative is expected to greatly reduce the potential effects determined for Alternative I (base case). Endangerd whales and Steller sea lions are expected to experience only minimal effects from potentially disturbing activities and muds and cuttings contamination.	The overall effect of this alternative is expected to be essentially the same as determined for proposed Alternative I; effects on endangered whales nonlethal, Steller sea lions requiring at least 1 generation for recovery, Steller's eider requiring 2 generations for recovery	The overall effect of this alternative on endangered whales is expected to be somewhat less than the minimal effect discussed for Alternative I; effects on endangered whales nonlethal; Steller sea lion losses from oil-spill effects could require a recovery period of at least one generation; wintering Steller's eiders losses requiring 2 generations for recovery; Short-tailed albatross, Aleutian Canada goose and peregrine falcon are not expected to experience adverse effects.	Compared to Alternative I (base case), cumulative effects on (1) endangered whales is expected to be similar except that disturbance and other factors on fin and humpback whales is likely to be more severs, but still not significantly affecting population distribution, abundance, or mortality; (2) Steller sea lions are expected to be at least twice as great (because of greater oil spill mortality) and require more than 2 generation for recovery, (3) short-tailed albatross and peregrine falcon are expected to be similar, (4) Aleutian Canada goose similar if there is no accelerated loss of winter habitat, and (5) Steller's eider at least twice as great (because of greater oil spill mortality).

TERRESTRIAL MAMMALS

Alternative VII (General Fisheries Deferral Alternative–Exploration Only)	Alternative VIII (Northern Deferral Alternative)	Alternative IX (Kennedy Entrance Deferral Alternative)	Cumulative Case
This alternative is expected to greatly reduce the potential effects of Alternative I (base case); populations of terrestrial mammals are not expected to be affected. Overall effects are expected to include the displacement of very small numbers (< 10) of brown bears, river otters, or other terrestrial mammals within 1 mi of support facilities in the Kenai/Niksiki area or along traffic routes nearshore.	Effects are expected to be about the same as the Alternative I (base case). Oil-spill effects on brown bears, river otters, and other terrestrial mammals are expected be slightly reduced locally along the coasts of Iniskin, Chinitna, and Tuxedni Bays and on the Kenai Peninsula.	Effects are expected to be about the same as described under the base case. Oil-spill effects on brown bears, river otters, and other terrestrial mammals are expected be reduced locally along the coasts of Kachemak Bay and lower Kenai Peninsula.	Overall cumulative effects are expected to include the long-term (several generation) loss of old-growth-forest habitat (perhaps several thousand acres), increased human access and disturbance resulting in increased mortality, reduced distribution and reduced abundance of brown bears and to a lesser extent reduced numbers of river otters due to oil spill losses (perhaps as many as 100) and the loss of a number of black-tailed deer (perhaps as many as 100) from oil spills and reduced productivity from forest habitat loss. Total recovery is expected to take several generations. The contribution of the Alternative I (base case) to the cumulative case is expected to be 50 % or less of the mortality, < 1 percent of the habitat loss, and no effect on regional populations of terrestrial mammals.

ECONOMY

Alternative I (Base Case)	Alternative IV (Wildlife Concentration Deferral Area)	Alternative V (Coastal Fisheries Deferral Alternative)	Alternative VI (Pollock-Spawning Area Deferral Alternative)
Alternate I would generate changes between zero and 3% in resident employment, <3% in average income, <5 percent in cost of living, <2 percent in property tax, and <5% in sales taxes on the western side of the KPB annually for <5 years. Property-tax revenue of $2.2 million for the KPB and $0.4 million (in 1993 dollars) for the State would be added annually after the year 2002. A large (50,000 bbl) oil spill would generate 5,000 cleanup jobs for 6 months in the first year, declining to zero by the fourth year following the spill; the chance of one or more large (≥1,000 bbl) oil spills occurring is estimated to be 27%. Local communities would experience a doubling of housing rents for 1 year.	Effects are expected to be the same as for the Alternative I (base case).	Changes generated would be between 1 and 4% in resident employment, 3% in cost of living, and <4% in sales tax. Average income, cost of living, property taxes and property-tax revenue for the KPD and State, and jobs created and changes in housing rents as a result of a large spill would be the same as the Alternative I (base case).	Effects are expected to be the same as the Alternative I (base case).

COMMERCIAL FISHERIES

Alternative I (Base Case)	Alternative IV (Wildlife Concentration Deferral Area)	Alternative V (Coastal Fisheries Deferral Alternative)	Alternative VI (Pollock-Spawning Area Deferral Alternative)
Economic losses for 2 years following a 50,000 bbl oil spill are estimated to range from about 15 to 65%/year for the Cook Inlet commercial fishing industry and 5 to 25%/year for the Kodiak commercial fishing industry. The chance of one or more oil spills ≥1,000 bbl is estimated to be 27%	Effects are expected to be similar to Alternative I (base case). The chance of one or more oil spills ≥1,000 bbl is estimated to be 23%	Effects are expected to be similar to Alternative I (base case). The chance of one or more oil spills ≥1,000 bbl is estimated to be 19%	Effects are expected to be similar to Alternative I (base case). The chance of one or more oil spills ≥1,000 bbl is estimated to be 21%

SUBSISTENCE-HARVEST PATTERNS

Alternative I (Base Case)	Alternative IV (Wildlife Concentration Deferral Area)	Alternative V (Coastal Fisheries Deferral Alternative)	Alternative VI (Pollock-Spawning Area Deferral Alternative)
Subsistence harvests would be reduced or substantially altered by as much as 50% in one or more southern Kenai Peninsula communities for at least 1 year and to a lesser extent for selected subsistence resources 2-3 years beyond; effects are caused by one or more large (≥1,000 bbl) accidental oil spills which have a 27% chance of occurring.	Effects are expected essentially to be the same as the Alternative I (base case); although deferral of selected blocks near Tuxedni Bay or the Barren Island could provide a measure of protection for subsistence resources.	Effects are expected essentially to be the same as the Alternative I (base case), although deferral of a substantial number of blocks near shoreline or island groups could reduce the potential for effects on subsistence harvests to some extent.	Effects are expected essentially to be the same as the Alternative I (base case), although deferral of all southern blocks near Cape Douglas could provide a measure of protection for subsistence resources, especially marine mammals, which use pollock as a primary food source.

ECONOMY

Alternative VII (General Fisheries Deferral Alternative–Exploration Only)	Alternative VIII (Northern Deferral Alternative)	Alternative IX (Kennedy Entrance Deferral Alternative)	Cumulative Case
Change generated would be <1 % increase in resident employment, resident income, local prices, and local taxes in the KPB annually for <3 years.	Changes generated would be between 1 and 4 percent in resident employment, <3 percent in average income, <3 percent in cost of living, <2 percent in property tax, and <4 percent in sales taxes on the western side of the Kenai Peninsula annually for <5 years. Property-tax revenue of $1.7 million for the KPB and $0.4 million for the State (in 1993 dollars) would be added annually after the year 2002. A large oil spill, with a 19-percent probability of occurring and contacting land, would generate 5,000 cleanup jobs for 6 months in the first year, declining to zero by the fourth year following the spill. Local communities would experience a doubling of housing rents for 1 year.	Changes generated would be between zero and 3 percent in resident employment, <3 percent in average income, <5 percent in cost of living, <2 percent in property tax, and <5 percent in sales taxes on the western side of the Kenai Peninsula annually for <5 years. Property-tax revenue of $2.2 million for the KPB and $0.4 million (1993 dollars) for the State would be added annually after the year 2002. A large oil spill, with a 27 percent probability of occurring and contacting land, would generate 5,000 cleanup jobs for 6 months in the first year, declining to zero by the fourth year following the spill. Local communities would experience a doubling of housing rents for 1 year.	Changes generated would be increases of between 1 and 4% in resident employment, <6 percent in cost of living, <3 percent in property tax, and <5 percent in sales tax on the western side of the KPB annually for <5 years and 1% for another 15 years. Property tax would increase $2.2 million for the KPB and $0.4 million for the State (in 1993 dollars) annually after the year 2002. A large oil spill would generate 5,000 cleanup jobs for 6 months in the first year, declining to zero by the fourth year following the spill. Local communities would experience a doubling of housing rents for 1 year.

COMMERCIAL FISHERIES

Alternative VII (General Fisheries Deferral Alternative–Exploration Only)	Alternative VIII (Northern Deferral Alternative)	Alternative IX (Kennedy Entrance Deferral Alternative)	Cumulative Case
Economic loses for the Cook Inlet and Kodiak commercial fishing industries are estimated to be about one-half those of Alternative I (base case).	Effects are expected to be similar to Alternative I (base case). The chance of one or more oil spills ≥1,000 bbl is estimated to be 19%	Effects are expected to be similar to Alternative I (base case). The chance of one or more oil spills ≥1,000 bbl is estimated to be 27%	Economic loses for the Cook Inlet and Kodiak commercial fishing industries are estimated to be about twice those of the Alternative I (base case).

SUBSISTENCE-HARVEST PATTERNS

Alternative VII (General Fisheries Deferral Alternative–Exploration Only)	Alternative VIII (Northern Deferral Alternative)	Alternative IX (Kennedy Entrance Deferral Alternative)	Cumulative Case
Effects would be localized, of short duration, and not of such an extent to create measurable changes in the availability or accessibility of subsistence resources.	Effects are expected essentially to be the same as the Alternative I (base case), although deferral of a substantial number of blocks north of Anchor Point could reduce the potential for effects on subsistence harvests.	Effects are expected essentially to be the same as the Alternative I (base case), although deferral of a considerable number of blocks near shoreline or island groups could reduce the potential for effects on subsistence harvests to some extent.	Subsistence harvests would undergo continuing disruptions and periodic reductions over time and be reduced by as much as 50% in 1 or more Kodiak Island and lower Cook Inlet communities for at least 1 year and to a lesser extent for selected resources 2-3 years beyond; effects are caused by one or more large (≥1,000 bbl) oil spills which have a 64% chance of occurring.. The base case contributes primarily to effects in lower Cook Inlet communities.

SOCIOCULTURAL SYSTEMS

Alternative I (Base Case)	Alternative IV (Wildlife Concentration Deferral Alternative)	Alternative V (Coastal Fisheries Deferral Alternative)	Alternative VI (Pollock-Spawning Area Deferral Alternative)
One or more southern Kenai Peninsula communities would undergo periodic episodes of increased individual, social, and institutional stress and disruption that would last for several years in each instance and endure in memory for decades; effects are caused by both pre-lease and potential post-lease processes and events.	Effects are expected essentially to be the same as the Alternative I (base case).	Effects are expected essentially to be the same as the Alternative I (base case); although deferral of selected blocks near Tuxedni Bay or the Barren Island could provide a measure of protection for subsistence resources.	Effects are expected essentially to be the same as the Alternative I (base case).

ARCHAEOLOGICAL AND CULTURAL RESOURCES

Alternative I (Base Case)	Alternative IV (Wildlife Concentration Deferral Alternative)	Alternative V (Coastal Fisheries Deferral Alternative)	Alternative VI (Pollock-Spawning Area Deferral Alternative)
The effects of cleanup activities, vandalism, and inadvertent contact with archaeological sites and shipwrecks on the shore and within the State's 3-mi zone over the duration of the lease would affect <3 percent (an estimated <30 sites) of those resources.	Effects are expected to be the same as the Alternative I (base case).	Effects are expected to be the same as the Alternative I (base case) but fewer (about 5) archaeological sites and shipwrecks would be affected.	Effects are expected to be the same as the Alternative I (base case) but fewer (about 10) archaeological sites and shipwrecks would be affected.

NATIONAL AND STATE PARKS AND RELATED AREAS

Alternative I (Base Case)	Alternative IV (Wildlife Concentration Deferral Alternative)	Alternative V (Coastal Fisheries Deferral Alternative)	Alternative VI (Pollock-Spawning Area Deferral Alternative)
Effects of a large (50,000-bbl) oil spill are expected to very slightly reduce visual qualities and slightly reduce visitor rates for a year following the spill; <3% of the physical and biological resources would be affected for about 3 years. The chance of one or more large (≥1,000 bbl) oil spills occurring is estimated to be 27% Recreational fishing would drop slightly in areas affected by a spill for a year or two after the spill. The effects of oil-spill cleanup activities are expected to be greater than the effects of the oil spill.	Effects are expected to be the same as the Alternative I (base case)	Effects are expected to be the same as the Alternative I (base case)	Effects are expected to be the same as Alternative I (base case)

AIR QUALITY

Alternative I (Base Case)	Alternative IV (Wildlife Concentration Deferral Alternative)	Alternative V (Coastal Fisheries Deferral Alternative)	Alternative VI (Pollock-Spawning Area Deferral Alternative)
Effects on onshore air-quality standards is expected to be minimal and not sufficient to harm vegetation; Alternative I air emissions are expected to be 20.4% of the maximum allowable PSD Class I increments and would not make the concentrations of criteria pollutants in the onshore ambient air approach the air-quality standards. A light, short-term coating of soot over a localized area could result from oil fires.	Effects are expected to be the same as the Alternative I (base case)	Effects are expected to be the same as the Alternative I (base case)	Effects are expected to be the same as the Alternative I (base case)

SOCIOCULTURAL SYSTEMS

Alternative VII (General Fisheries Deferral Alternative--Exploration Only)	Alternative VIII (Northern Deferral Alternative)	Alternative IX (Kennedy Entrance Deferral Alternative)	Cumulative Case
Affected publics in one or more southern Kenai Peninsula communities would undergo increased individual, social, and institutional stress and disruption during the pre-lease planning process. Otherwise, little or no effects on sociocultural systems are expected.	Effects are expected essentially to be the same as the Alternative I (base case; although deferral of all blocks north of Anchor Point would tend to reduce stress and anxiety among residents of Kenai Peninsula communities due to the absence of a visual threat and the potential for fisheries conflicts.	Effects are expected essentially to be the same as the Alternative I (base case; although deferral of a considerable number of blocks near shoreline and island groups should reduce stress and anxiety in Nanwalek and Port Graham to some extent.	One or more southern Kenai Peninsula and Kodiak Island communities would experience seasonal and cyclical change over time and undergo periodic episodes of increased individual, social, and institutional stress and disruption that could last for several years in each instance and in some cases endure in memory for decades; effects are caused by both pre-lease and potential post-lease processes and events. The base case contributes primarily to effects on Kenai Peninsula communities

ARCHAEOLOGICAL AND CULTURAL RESOURCES

Alternative VII (General Fisheries Deferral Alternative--Exploration Only)	Alternative VIII (Northern Deferral Alternative)	Alternative IX (Kennedy Entrance Deferral Alternative)	Cumulative Case
Effects would be due to exploration activities and indiscriminate contact with archaeological sites and affect an estimated ≤1 percent of the archaeological sites and cultural resources.	Effects are expected essentially to be the same as the Alternative I (base case.	Effects are expected essentially to be the same as the Alternative I (base case.	Effects would amount to a total disturbance of 5 % of all the resources. Oil-spill disturbance would amount to 1-3% of the archaeological and cultural resources for each particular area contacted by a spill.

NATIONAL AND STATE PARKS AND RELATED AREAS

Alternative VII (General Fisheries Deferral Alternative--Exploration Only)	Alternative VIII (Northern Deferral Alternative)	Alternative IX (Kennedy Entrance Deferral Alternative)	Cumulative Case
Effects would be from exploration activities and have minimal impacts of visual qualities, visitor rates and biological and physical resources.	Effects are expected essentially to be the same as the Alternative I (base case.	Effects are expected essentially to be the same as the Alternative I (base case.	Effects would amount to a disturbance of about 5% of all resources. Disturbances from a large oil spill would effect 1-3% of the resources and recovery would occur in 3 years. About 50-60% of the effects are attributable to the Alternative I (base case).

AIR QUALITY

Alternative VII (General Fisheries Deferral Alternative--Exploration Only)	Alternative VIII (Northern Deferral Alternative)	Alternative IX (Kennedy Entrance Deferral Alternative)	Cumulative Case
Effects are expected to be about one-third those of the Alternative I (base case).	Effects are expected essentially to be the same as the Alternative I (base case.	Effects are expected essentially to be the same as the Alternative I (base case.	Effects are expected to be the same as the Alternative I (base case)

COASTAL ZONE MANAGEMENT			
Alternative I (Base Case)	**Alternative IV (Wildlife Concentration Deferral Alternative)**	**Alternative V (Coastal Fisheries Deferral Alternative)**	**Alternative VI (Pollock-Spawning Area Deferral Alternative)**
A potential for conflict with the habitat standard was identified, primarily as a result of habitat effects of a large (50,000-bbl) oil spill; the chance of one or more large (≥1,000 bbl) oil spills occurring is estimated to be 27%	Effects are expected to be the same as the Alternative I (base case).	Effects are expected to be the same as the Alternative I (base case) although localized reductions in important habitats in Cook Inlet and Shelikof Strait are expected.	Effects are expected to be the same as the Alternative I (base case).

Alternative VII (General Fisheries Deferral Alternative--Exploration Only)	Alternative VIII (Northern Deferral Alternative)	Alternative IX (Kennedy Entrance Deferral Alternative)	Cumulative Case
Effects are expected to be the same as the Alternative I (base case), although localized reductions in important habitats in Cook Inlet and Shelikof Strait are expected.	Effects are expected to be the same as the Alternative I (base case) although localized reductions in important habitats in Cook Inlet and Shelikof Strait are expected.	Effects are expected to be the same as the Alternative I (base case) although localized reductions in important habitats in Cook Inlet and Shelikof Strait are expected.	Potential conflicts with the Statewide standards and district policies of the ACMP are comparable to those in the Alternative I (base case). Additional policies are applicable and emphasize consideration of cumulative effects in decisionmaking, especially those effects associated with air and water quality.

SECTION III

DESCRIPTION OF THE AFFECTED ENVIRONMENT

Section III Table of Contents

III. DESCRIPTION OF THE AFFECTED ENVIRONMENT

III. DESCRIPTION OF THE AFFECTED ENVIRONMENT

A. Physical Considerations:

1. Geology:

a. Geologic Setting: A belt of Mesozoic and Cenozoic sedimentary rocks underlies the upper Cook Inlet on the northeast and the Alaska Peninsula on the southwest. Marine Mesozoic rocks found locally along this belt may be more than 12,000 meters (m) thick. The continental Cenozoic rocks are as much as 7,600 m thick. Four major geologic features with northeast trends flank Cook Inlet: 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 (Fisher and Magoon, 1978). A generalized geologic map is shown in Figure III.A.1-1.

The presence of Upper Triassic and Early Jurassic rocks surrounding the Sale 149 area and in offshore wells in the Sale 149 area indicates that this section may be continuous beneath the inlet and the strait. Middle and Upper Jurassic marine sedimentary rocks up to 7,000 m thick unconformably overlie the Lower Jurassic rocks. The Middle Jurassic rocks may be the source for the oil being produced in upper Cook Inlet (Magoon and Claypool, 1981).

The Mesozoic rocks beneath lower Cook Inlet form a broad geosyncline with a northeast-trending axis. The northwestern limb is deeply eroded, and mainly Jurassic rocks are exposed. An unconformity truncates the southeastern limb. A number of local structures are superimposed on the geosyncline; they include a lineation of small anticlines near the southeastern flank of lower Cook Inlet and the Augustine-Seldovia Arch (Fig. III.A.1-2) (Fisher and Magoon, 1982).

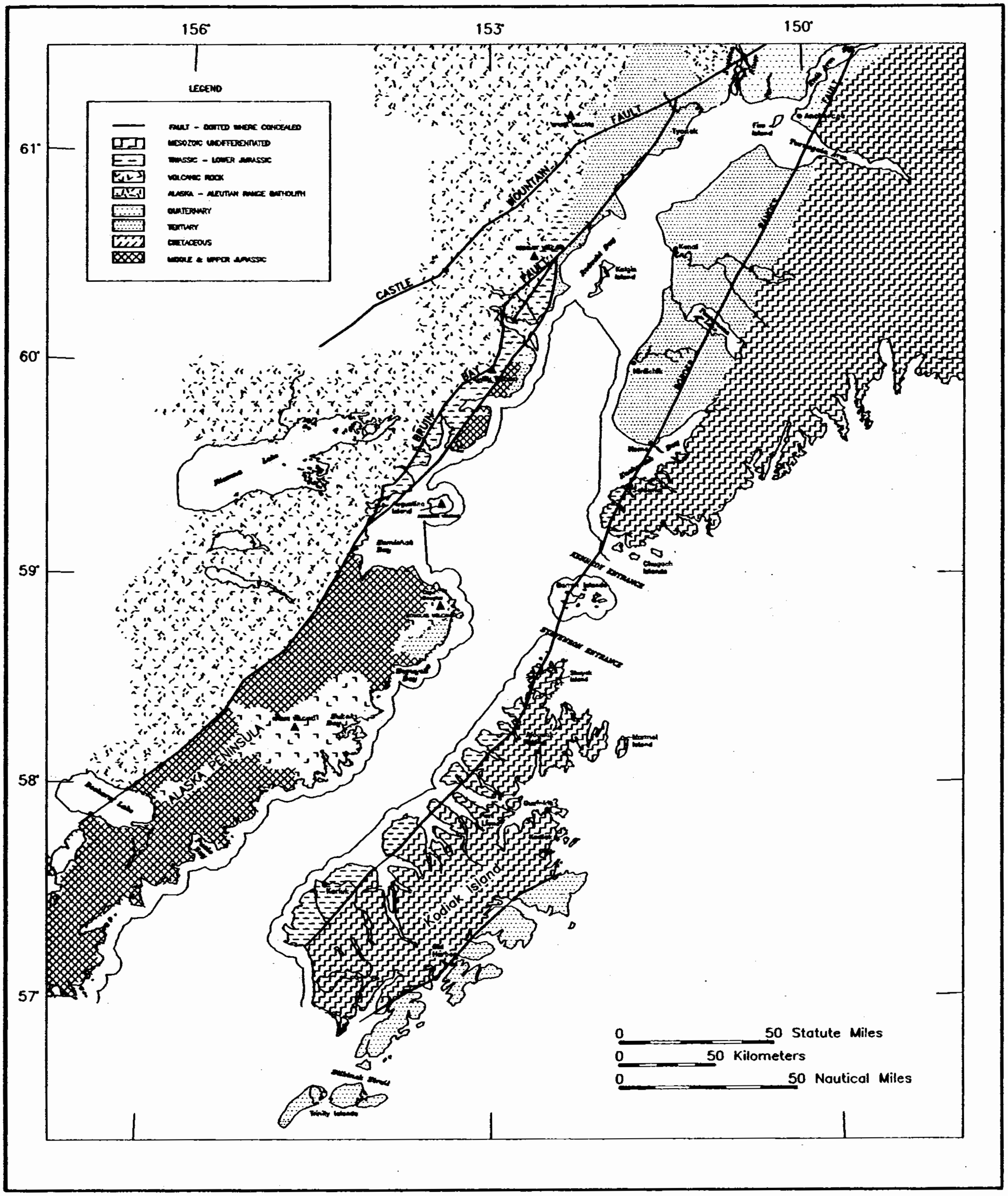
Fisher and Magoon (1982) and Appendix A of this document provide additional information regarding the geological description in the Sale 149 area.

b. Physiography: Cook Inlet is a tidal estuary with a northeast-southwest orientation. It is approximately 370 kilometers (km) long and 139 km wide at the mouth. The northern inlet consists of an elongated trough that bifurcates around Kalgin Island. Shallow platforms flank the trough on the eastern and western sides. Water depths range from 20 m on the platforms to over 80 m within the trough. A triangular-shaped plateau lies south of the trough. West of the plateau is a v-shaped ramp that divides the shallow northern area of the inlet from the deeper area in the south. The depth at the top of the ramp is approximately 70 m, and the base is about 115 m. The southern ramp slopes uniformly into Shelikof Strait. Other features in the southern part of the inlet include the deep troughs in the Stevenson and Kennedy Entrances. Both have depths over 200 m and are separated by the topographic high that forms the Barren Islands (Fig. III.A.1-3).

c. Other Geological and Environmental Considerations:

(1) Earthquakes: Lower Cook Inlet is situated in one of the most active seismic zones in the world. The area is located along the boundary of the Aleutian trench, which is the site of subduction between the Pacific and North American plates (Fig. III.A.1-4). Sykes (1971) estimated the recurrence interval of great earthquakes (magnitude greater than [>]7.8 as measured on the Richter scale) in the Cook Inlet to be a minimum of 33 years. Plafker and Rubin (1967) estimated the maximum interval to be 800 years. Earthquakes of this magnitude are generated in the shallow thrust zone, which is associated with the convergence of the earth's crust between the plates. Two areas known as the Shumagin and the Yakataga seismic gaps have not had great earthquakes occur since 1917 and 1899, respectively. Seismologists believe the two areas have a high potential to be the site of a great earthquake (Nishenko and Jacob, 1990) (Fig. III.A.1-4). Deeper earthquakes with a magnitude range of 5 to 6 show clusters beneath Iliamna, Douglas, and Augustine volcanoes (Pulpan, 1979).

Over 100 earthquakes of magnitude >6 have occurred in the Cook Inlet area since 1902 (Hampton 1982). The last great earthquake to affect the area occurred in 1964. A detailed account of the 1964 earthquake can be found in material published by the National Academy of Sciences in 1971.



Source: After Hampton, 1982

Figure III.A.1-1. Onshore Geology of Areas Adjacent to Cook Inlet and Shelikof Strait.

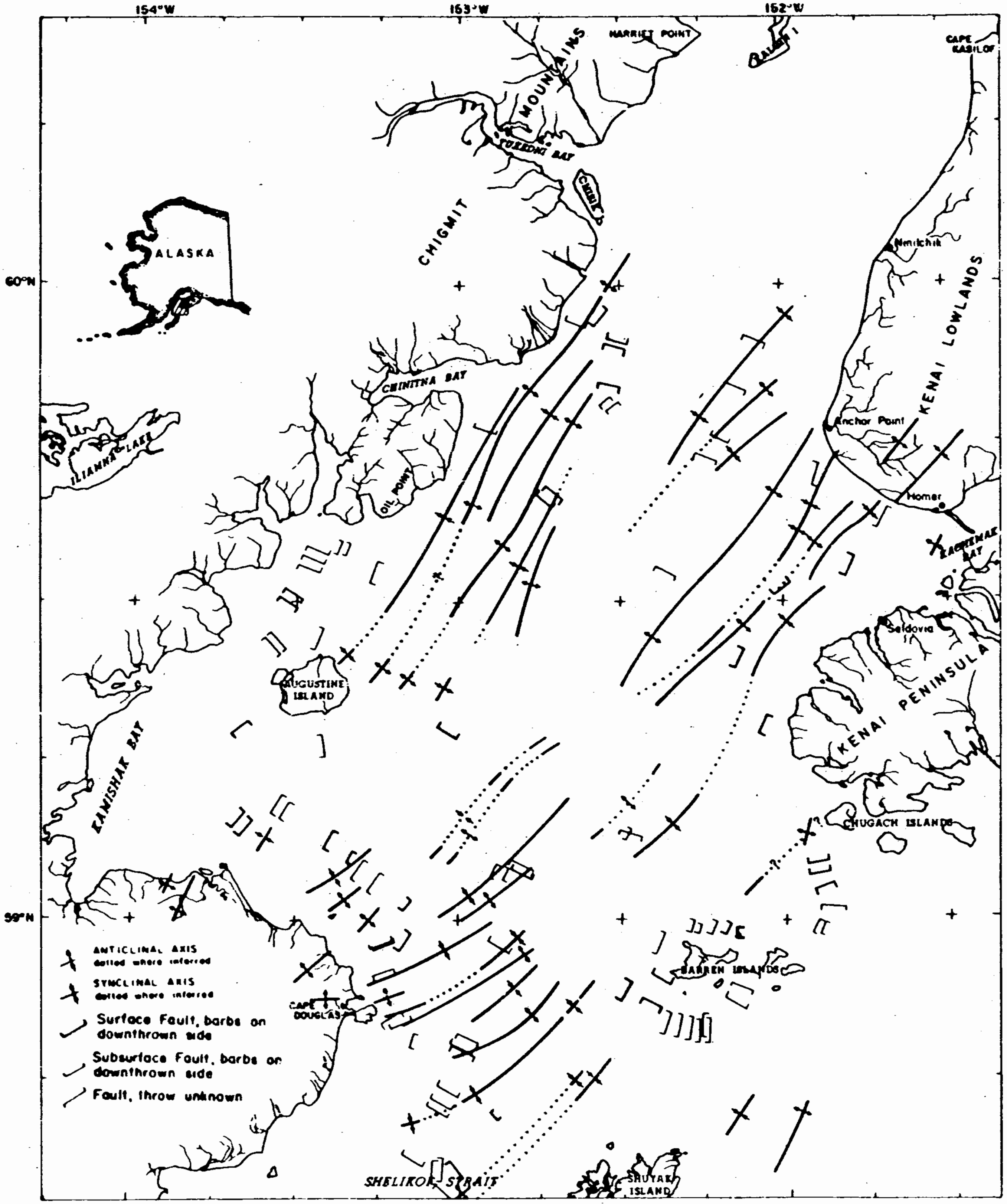
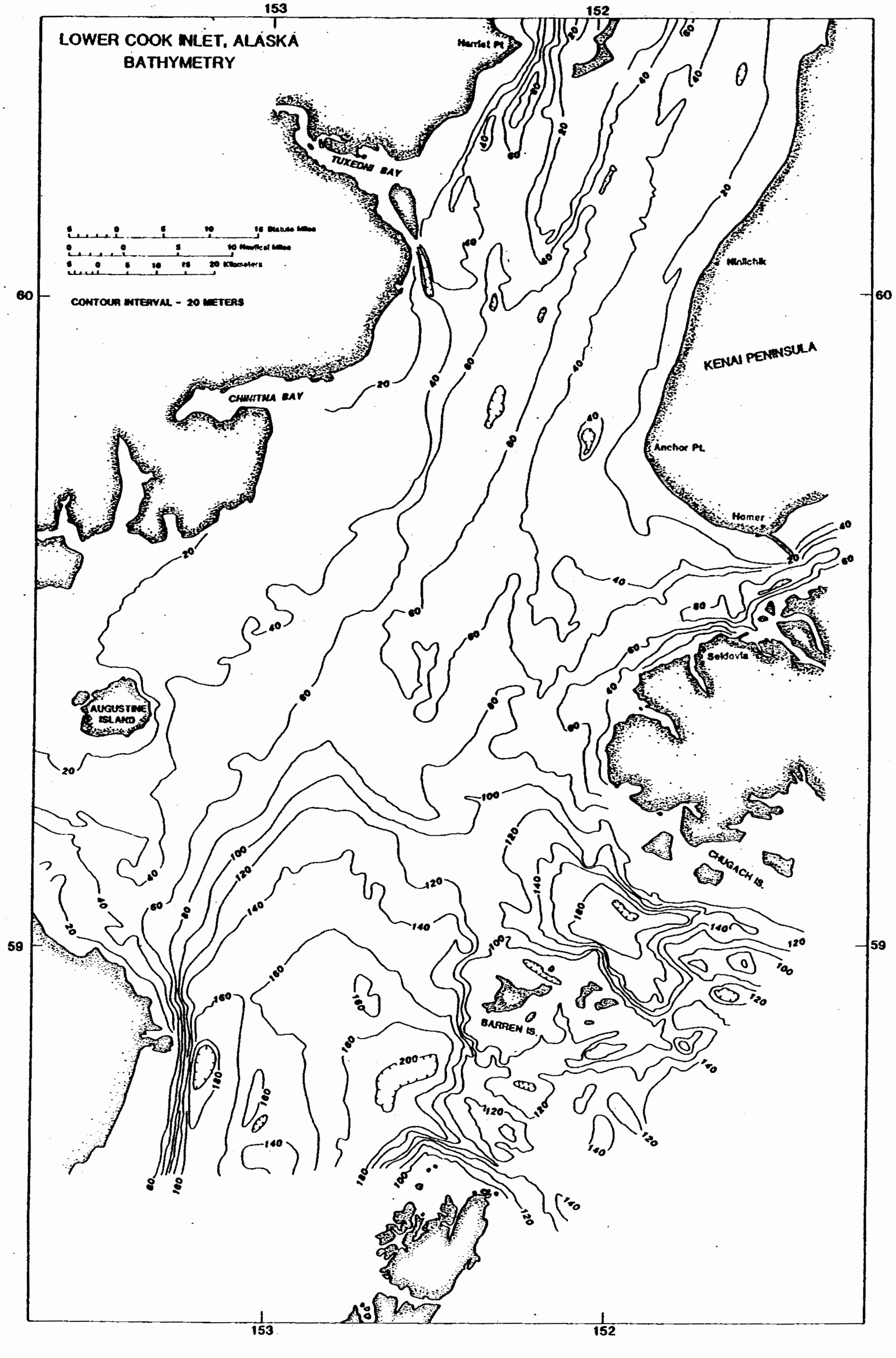
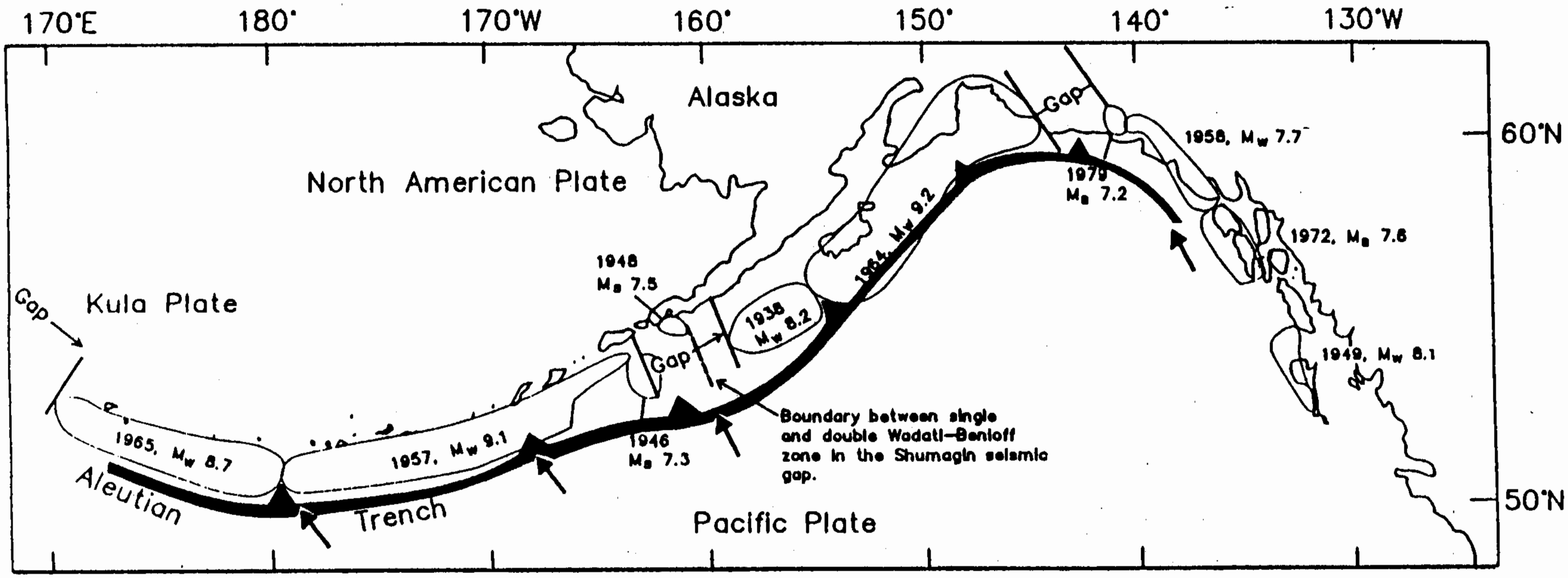


Figure III.A.1–2. Shallow Structures and Faults in Lower Cook Inlet.



Source (Modified): Bouma et al., 1977

Figure III.A.1-3. Bathymetry Map of Lower Cook Inlet



Source: Adapted from Beavan et al., 1984, and Hudnut and Taber, 1987

Figure III.A.1-4. Rupture Zones in Southern Alaska and the Aleutian Arc. Seismic Gaps and Year and Size of the Most Recent Large Earthquakes Are Indicated. Solid Arrows Indicate Direction of Relative Plate Movements.

(2) Faults: Seismic mapping of lower Cook Inlet indicates that shallow faults in this area are short and nearly uniformly distributed. The only exceptions are concentrations located near the Barren Islands and between Augustine Island and Cape Douglas. Figure III.A.1-2 shows the locations of these faults. Movement has occurred along those faults since the Pleistocene, offsetting unconsolidated sediment. However, no activity has been discovered in recent times.

(3) Volcanism: The western boundary of Cook Inlet and Shelikof Strait—the Alaska Peninsula and the Aleutian Island arc—is one of the most active volcanic regions in the world (Fig. III.A.1-1). Seven volcanoes or volcanic complexes are situated along the northwest margin of Cook Inlet and Shelikof Strait. From north to south, these are Mt. Hayes, Mt. Spurr, Mt. Redoubt, Mt. Iliamna, Mt. Augustine, Mt. Douglas, and Mt. Katmai (Novarupta). With the exceptions of Mt. Hayes and Mt. Douglas, all have erupted in historic time, and all are considered likely to erupt in the future (Riehle 1985). The most recent eruption was Mt. Spurr in 1992. Within Shelikof Strait, several active volcanoes are located in and around Katmai National Park and Preserve. Novarupta (Katmai) erupted in 1912 and deposited 0.3 m of volcanic ash on Kodiak Island. Other eruptions from 1883 to present are Mt. Augustine—1883, 1935, 1963, 1976, and 1986; Mt. Redoubt—1902, 1966, and 1989-1990; Mt. Iliamna—1933 and 1947; and Mt. Spurr—1953 and 1992.

All of the volcanoes around the proposed lease-sale area are andesitic and are capable of violent eruptions. All result from the convergence of the North American and Pacific plates. Lava flows, pyroclastic, or debris flows should be considered a potential hazard to any coastal facilities located near an active volcano. Ash falls are not considered a major danger; however, the abrasive and corrosive effects could be a nuisance to oil and gas operations (Hampton, 1982).

Additional sources of information on volcanism in the lease-sale area include Coats (1950), Miller and Smith (1977), Davies and Jacob (1980), Detterman (1968), Pulpan and Kienle (1977), Swanson and Kienle (1988), and Pike and Clow (1981).

(4) Tsunamis and Seiches: Both tsunamis and seiches are a possibility in this area of high seismic and volcanic activity. Tsunamis can be generated when large volumes of seawater are displaced by tectonic movement of the seafloor or by large rockfalls or landslides or volcanism. Seiches start in partially or completely enclosed bodies of water by seismic activity or by large rock or landslides in coastal areas. A destructive tsunami was associated with the 1883 eruption of Mt. Augustine. The wave, 7 to 9 m high, traveled across the inlet and struck the western coast of the Kenai Peninsula and Kodiak Island. Some damage was done in lower Cook Inlet (Siebert, 1989; Kienle et al., 1987).

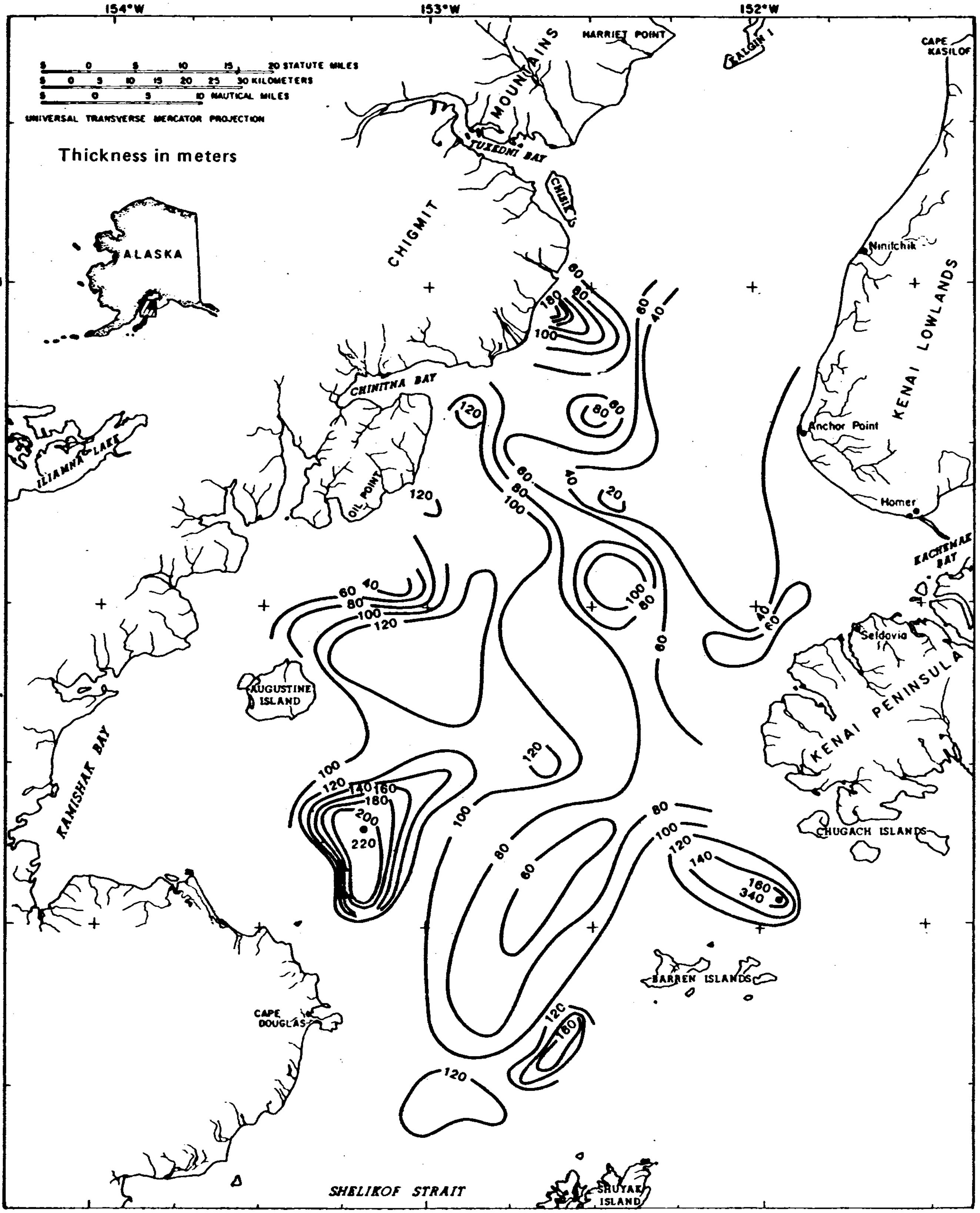
(5) Sediments/Seafloor Instability: Unconsolidated deposits in lower Cook Inlet range from less than [<]20 m to about 340 m thick (Fig. III.A.1-5). These deposits are reworked and redistributed coarse-grained glacial material (Rappeport, 1981; Sharma and Burell, 1970). Sedimentary environments range from some low-energy areas of accumulation to active areas of intense sediment transport.

Cook Inlet surficial sediment ranges from sandy silt to gravel and appears to possess favorable engineering conditions. This conclusion is based on the nature of the sediment, the generally low accumulation rates, and the low seafloor slopes that are present throughout most of the area. No evidence of gravitationally unstable slopes or soft, unconsolidated sediment has been found. Subsurface layers of liquefiable silt or fine sand may exist, and their presence can be determined by drilling. Mean grain size in the inlet generally decreases from north to south. Sand-size sediment is most abundant in the central inlet area.

Measurements of vane shear strength, water content, and plasticity of the shallow marine sediments indicate no unusual geotechnical problems.

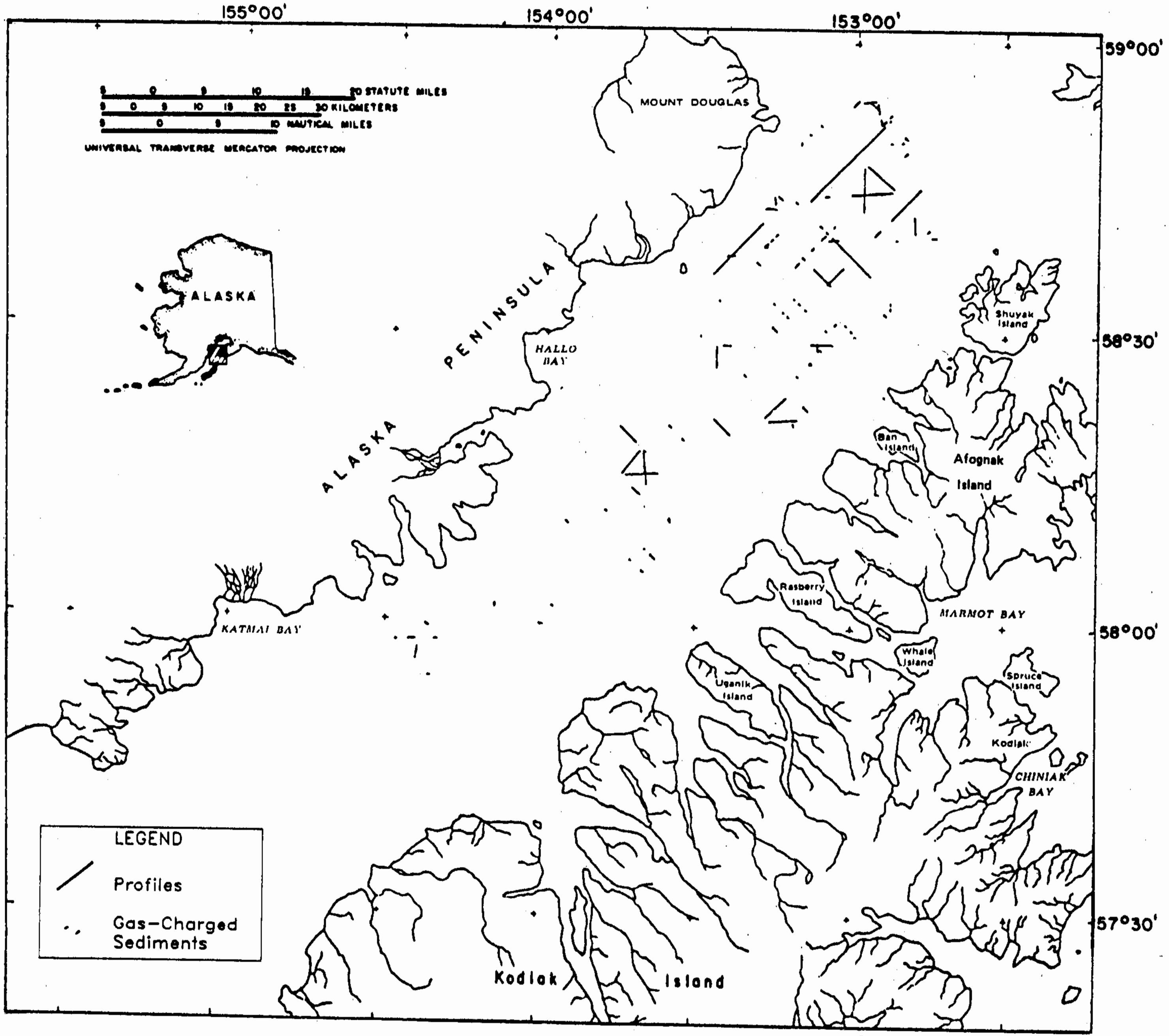
Additional sources on sediments in the sale area include Hampton et al. (1981), Hampton (1982), Sharma (1979), and Whitney et al. (1979).

(6) Gas-Charged Sediment: Indirect evidence of gas-charged sediments is found in a few localized areas of lower Cook Inlet. Anomalous acoustic returns in the seismic-reflection profiles suggest gas-charged sediments might be present in the shallow subsurface of Shelikof Strait (Fig. III.A.1-6). However,



Source: Hampton, 1982

Figure III.A.1–5. Thickness of Unconsolidated Sediment, Lower Cook Inlet.



Source: Hampton, 1982

Figure III.A.1-6. Possible Gas Charged Sediment Locations. Locations of Anomalous Acoustic Returns in Seismic-Reflection Profiles in Shelikof Strait.

sediment cores with low gas contents and the lack of seafloor seeps do not support the seismic evidence for gas-charged sediments.

Seafloor craters that average 50 m in diameter and <5 m in depth are found in the strait and are most likely due to sediment venting due to liquefaction; but they could indicate gas-charged sediment (Hampton, 1982).

(7) Large Bedforms: A wide variety of bedforms can be found in a large area of the central lower Cook Inlet. Seismic surveys and photographic or television systems have identified features such as sand waves, sand bands, sand ribbons, ripples, and comet marks (Fig. III.A.1-7). The sand waves have wave heights and wavelengths that approach 14 m and 950 m, respectively. The smaller sand waves have wavelengths that are <20 m. Typically, the length-to-height ratios exceed 20:1; ratios as low as 10:1 have been reported (Rappeport, 1981). Ripples have been detected with heights <10 cm and wavelengths <20 cm.

Factors such as sediment availability, sediment size, water depth, and current velocity play an important part in determining the type of bedform that will occur at a particular place. Sand waves and sand bands (fields of elongated bedforms) occur in the central, deeper areas where the supply of sand is greater. Sand ribbons (bodies of narrow, thin sand) occur nearer the margins of the inlet where sand is not as abundant. The largest sand waves are found in water depths from 80 to 110 m. Seismic-reflection records show large buried sand waves in the same area.

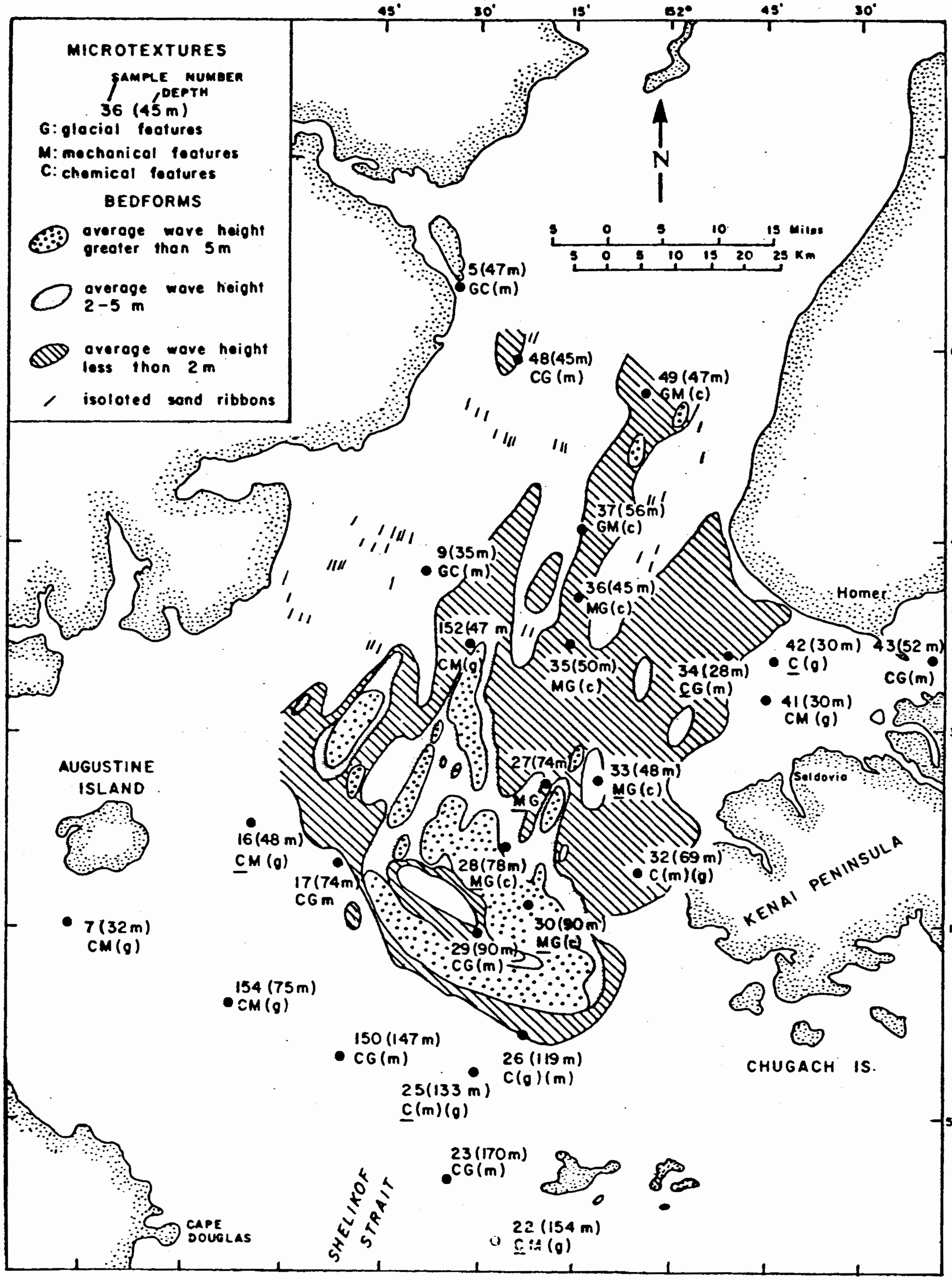
2. Meteorology: This section presents revised and updated information from the Lower Cook Inlet-Shelikof Strait (Lease Sale 60) and Gulf of Alaska/Cook Inlet (Lease Sale 88) (USDOI, Bureau of Land Management [BLM], Alaska OCS Office, 1981, and USDOI, MMS, Alaska OCS Region, 1984) FEIS's, which is hereby incorporated by reference.

a. Climate: In the lower Cook Inlet region, the climate is transitional from a maritime to a continental climate. Figure III.A.2-1 shows the mean monthly precipitation, sea-surface temperature, wind speed, wave height, air temperature, and visibility. Generally, lower Cook Inlet is a maritime climate—wetter and warmer than the upper Cook Inlet region, which exhibits some continental climatic features—dryer and cooler. Superstructure icing can occur throughout the lower Cook Inlet region (Fig. III.A.2-2).

Storm-surge development is unfavorable in most of lower Cook Inlet due to the rugged topography and steeply sloping seafloor (Wise, Comiskey, and Becker, 1981). However, the open-water stretch from Shelikof Strait to lower Cook Inlet can develop storm surges with west-southwest winds during the fall and winter when wind strength is sufficient (Wise, Comiskey, and Becker, 1981). Figure III.A.2-2 shows the general direction for storm-surge development.

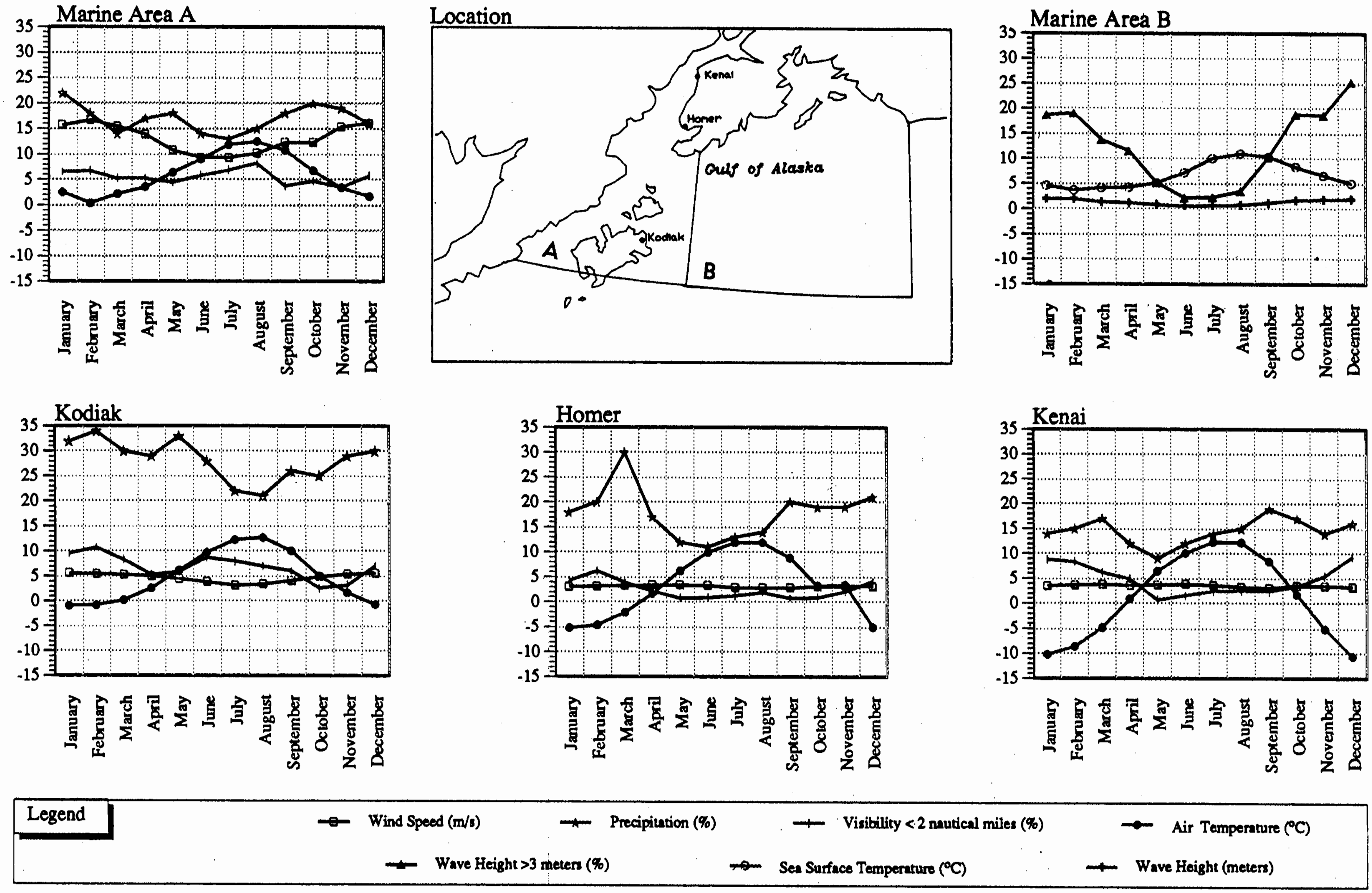
Overland and Heister's (1980) six seasonal Gulf of Alaska weather types, derived from (1) Sorkina's (1971) broad meteorological distinctions, (2) Putnins' (1966) reoccurring Gulf of Alaska patterns, and (3) 1977 to 1978 sea-level-pressure analyses, are listed in Table III.A.2-1. Figure III.A.2-3 shows that the Aleutian low-pressure center (Type II) occurs most often, followed by the low-pressure center over central Alaska (Type IV), the stagnating low off of Queen Charlotte Islands (Type VI), and the Pacific Cyclone, also known as the East Pacific High (Type V) (Overland and Hiester, 1980). Generally, winter is characterized by an inland high-pressure cell with frequent storm progressions from the west along the Aleutian chain. During summer, a low-pressure cell is over the inland area, with reduced storm passage. Summer and fall are characterized by a transition between these generalized patterns (Macklin, 1979). These generalized weather patterns provide relative wind magnitude and direction information over the Gulf of Alaska region.

b. Winds: Lower Cook Inlet wind fields respond predictably to the large-scale weather patterns, but with important modifications caused by the surrounding mountains (Macklin, Lindsay, and Reynolds, 1980). On the western side of Cook Inlet are the Alaska and Aleutian (Alaska Peninsula) Ranges; on the eastern side are the Talkeetna, Chugach, and Kenai Mountains and the Kodiak and Afognak Island lesser ranges. The nearly continuous Alaska Peninsula mountains act as an airflow barrier broken only by Kamishak Gap, a low-level area between Iliamna Lake and Kamishak Bay. Kennedy and Stevenson Entrances are major breaks in the eastern mountains from the Kenai Peninsula to the Kodiak-Afognak Islands Group. The inlet's and strait's mountainous borders block low-level airflow but also form airflow channels.



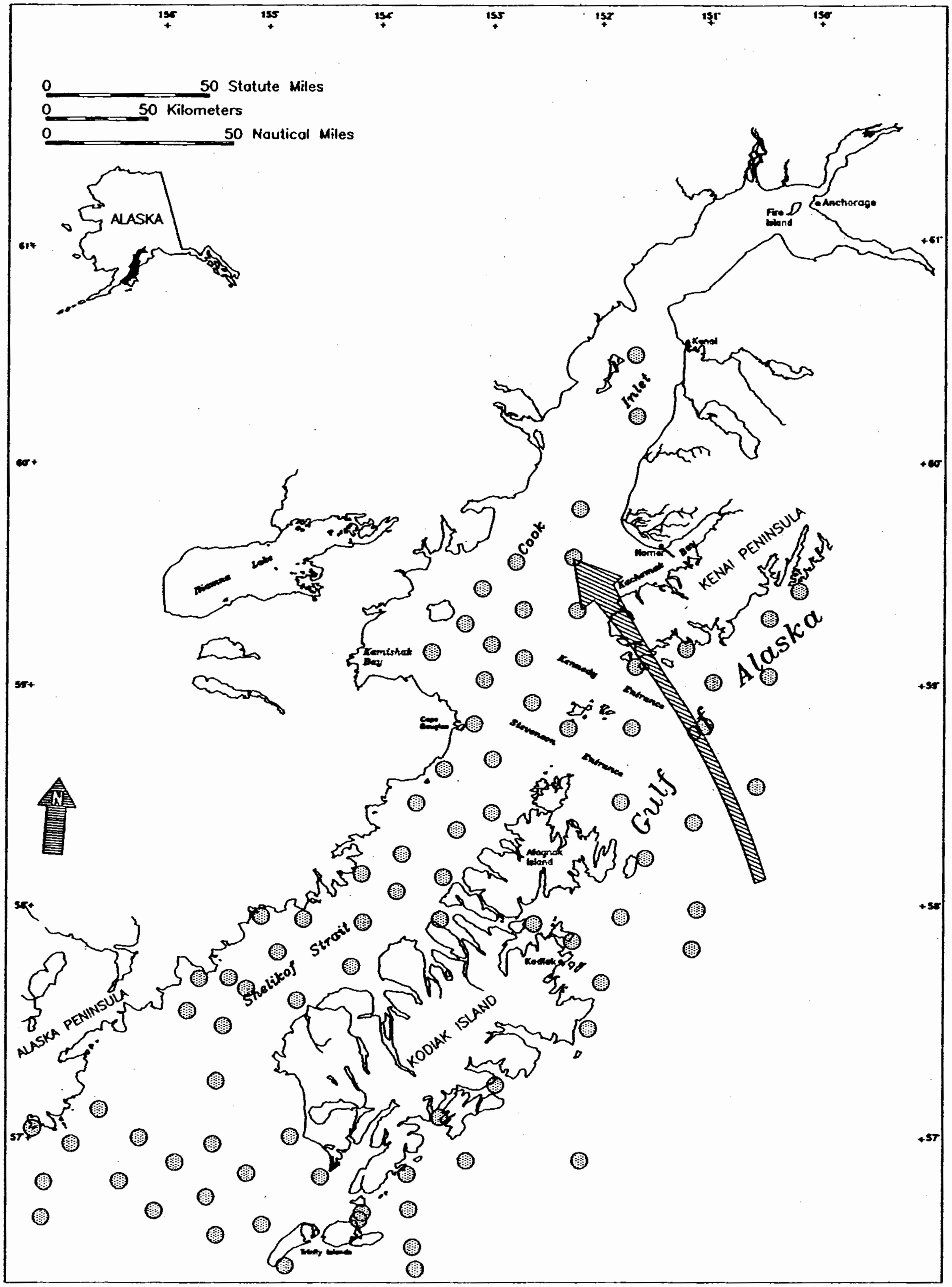
Source: Hampton, 1982

Figure III.A.1-7. Lower Cook Inlet Bedforms.



Source: Brower et al., 1988.

Figure III.A.2-1. Mean Monthly Precipitation, Sea-Surface Temperature, Wind Speed, Air Temperature, Visibility, and Wave Heights for the Cook Inlet/Shelikof Strait Region.



Source: Brower et al., 1988

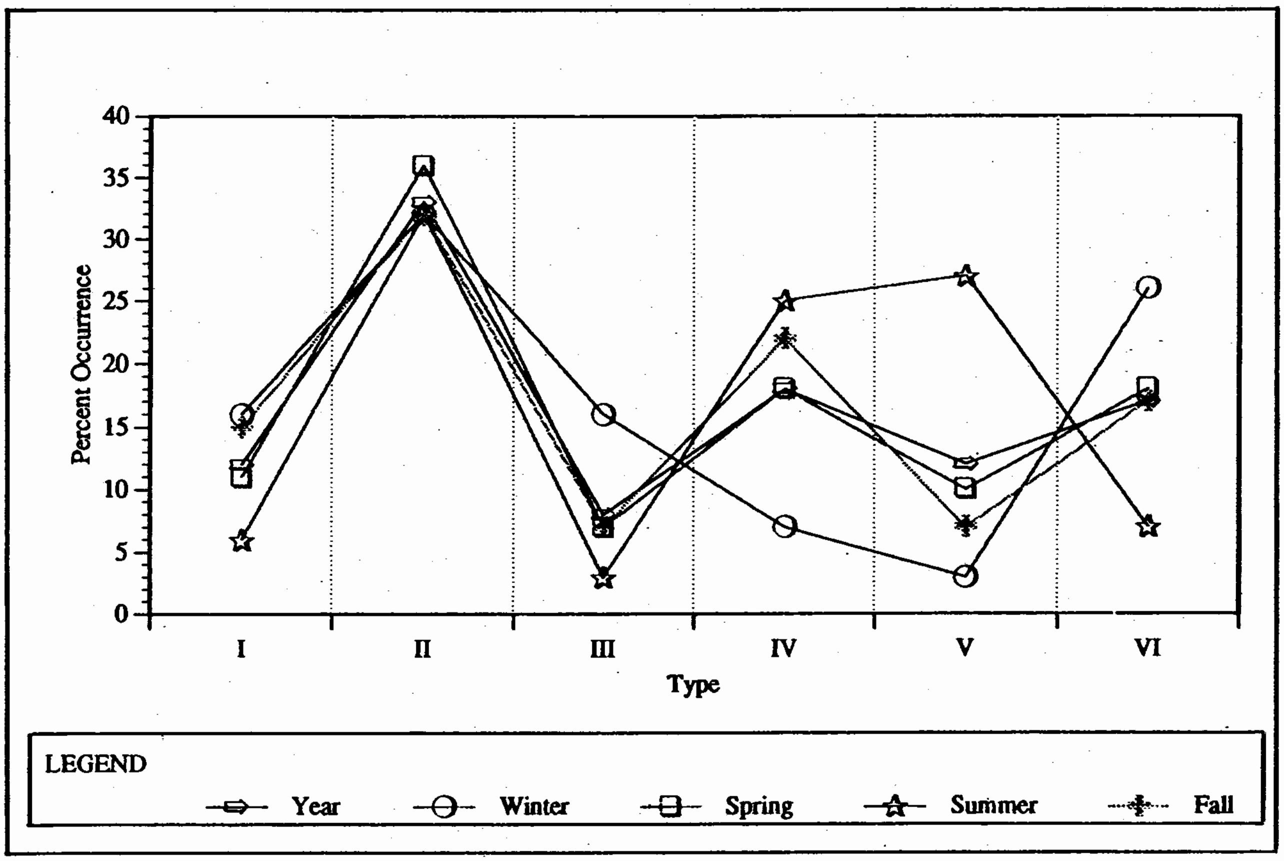
Note: Arrow Indicates Generalized Storm Surge Track.

Figure III.A.2-2. Location of Superstructure Icing Reports in the Cook Inlet and Shelikof Strait Region.

Table III.A.2-1.
Subjective Weather Types for the Northeast Gulf of Alaska

Type	Description	Sorkina Type	Putnins' Type	Dominant Season
I	Low in Gulf of Alaska	4c	A', A1, G, H	Winter
II	Aleutian Low	5b	A, C, E, Ao	Winter, Spring, Fall
III	High Pressure over Northern and Interior Alaska	6a	D, B, D1	Winter
IV	Low-pressure Center Over Central Alaska	1a	A", A2, F	Summer
V	Pacific Anticyclone	1b, 5a	A", A2, E', E'1	Summer
VI	Stagnating Low off of Queen Charlotte Islands	7a	D', E", E1, F1	Spring, Fall

Source: Overland and Hiester (1980)



Source: Overland and Hiester (1980)

Figure III.A.2-3. Percent Occurrence of Synoptic Weather Types.

(1) Gap Winds: Gap winds are observed over Cook Inlet (Macklin, Lindsay, and Reynolds, 1980; Macklin, Overland, and Walker, 1984; Gray 1988; Macklin, 1988; Lackmann and Overland, 1989; Macklin, Bond, and Walker, 1990). A gap wind is defined as an airflow accelerating due to the influence of an imposed synoptic-scale pressure gradient parallel to a sea-level channel axis (i.e., wind flowing from areas of high-pressure systems to areas of low-pressure systems along the sea-level channel) (Overland and Walter, 1981).

(a) Mountain (Orographic) Channeling: The mountains surrounding lower Cook Inlet form two wind channels that intersect over lower Cook Inlet (Fig. III.A.2-4; Macklin, Bond, and Walker, 1990). The north-south channel is formed by Cook Inlet, and the east-west channel is formed by Kamishak Gap, Kamishak Bay, and Kennedy and Stevenson Entrances. Lower Cook Inlet low-level windflow is constrained to these two channels (Macklin, 1979; Macklin, Overland, and Walker, 1984; Macklin, Bond, and Walker, 1990). Pressure-gradient-driven airflow in these channels may explain 84 percent of the measured Cook Inlet surface airflow (Macklin, 1979).

Wind-direction series indicate four prevalent surface-wind directions, down the channel from south-southeast during winter, up the channel north-northwest during summer, and cross-channel from the northeast and the southwest (Macklin, 1979). Typical average monthly offshore wind speeds are 8 to 10 meters per second (m/s) (15.6-19.5 knots [kn]) in winter and 5 to 10 m/s (9.7-19.5 kn) in summer (Hsu, 1988; Brower et al., 1988).

(b) Mountain-Gap Winds: Mountain-gap winds blowing through the Alaska Peninsula mountains differ from sea-level channel-gap winds because of the gravitational acceleration associated with the seaward-sloping terrain (Macklin, Bond, and Walker, 1990). Alaska's large-scale weather patterns produce mountain-gap winds blowing from the western Alaska Peninsula to the eastern side through passes, valleys, and gaps. Mountain-gap winds occur through Kamishak Gap throughout the year but are most prevalent in the winter, occurring several times a month (Macklin, 1988; Macklin, Bond, and Walker, 1990). Mountain-gap winds can have velocities greater than 51 m/s (99.2 kn) over the Barren Islands (Macklin, 1988). Mountain-gap winds create willawas and water spouts that can create hazardous conditions for mariners and aviators.

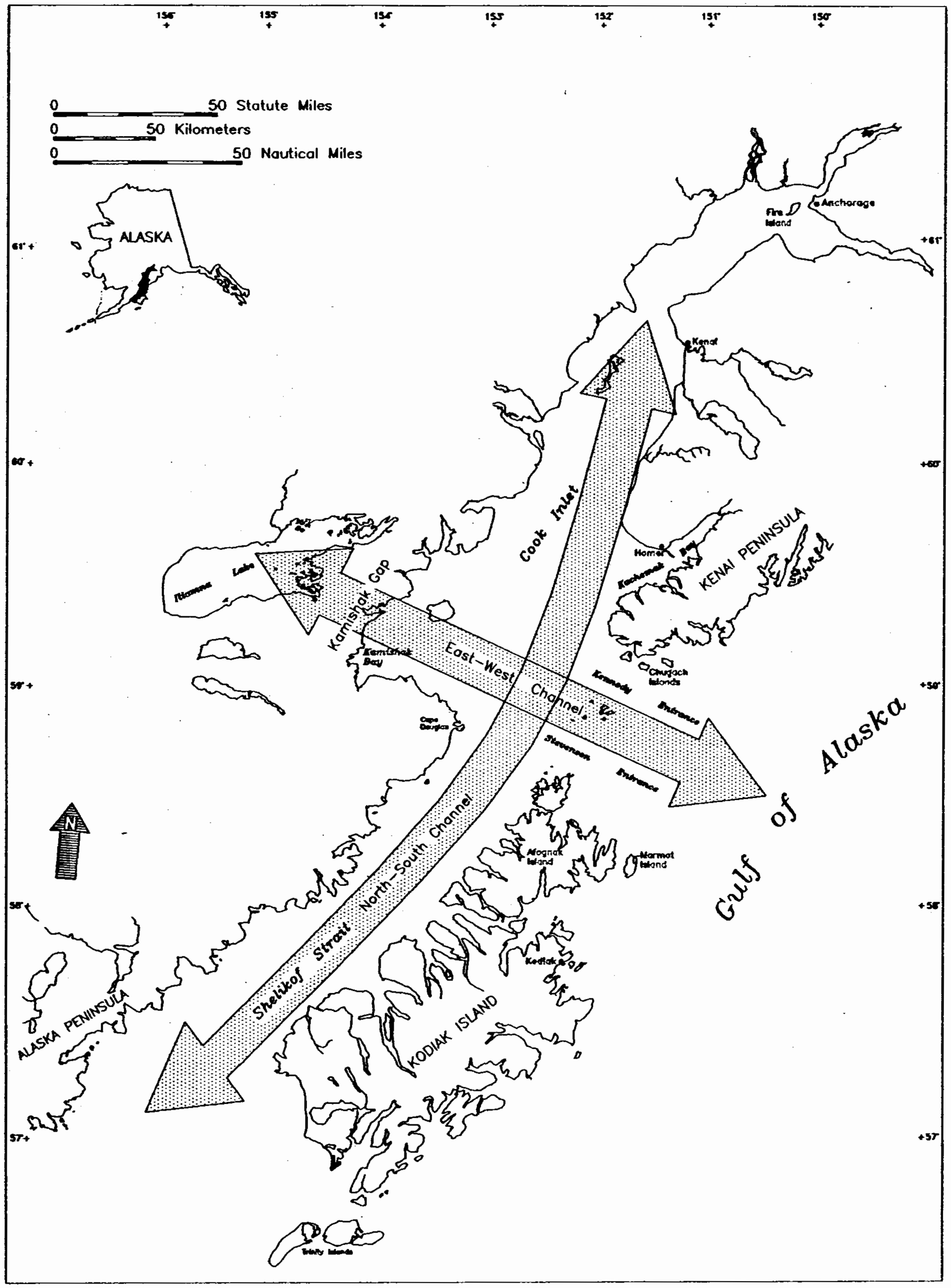
(2) Drainage (Katabatic) Winds: The mountain- channeled winds are influenced by small-scale features such as drainage winds (cold airmass moving downslope) and wake flow. Drainage winds occur along Cook Inlet's mountainous southeastern and western coasts draining from glaciated valleys (Macklin, 1979). Kachemak Bay exhibits drainage winds, because several Kenai Peninsula glaciers terminate at its eastern end (Reynolds, Macklin, and Walter, 1979). In winter, cold continental air drains from the mountainous regions surrounding northern Cook Inlet. Drainage-wind velocities can exceed 50 m/s (97.2 kn) and extend for tens of kilometers offshore (Reynolds, Macklin, and Hiester, 1981). Windflow around Mount Augustine has been characterized as wake flow with typical velocities from 3 to 8 m/s (5.8-15.6 kn) (Macklin, Lindsay, Reynolds, 1980; Macklin, 1979).

3. Physical Oceanography: This section presents revised and updated information from lower Cook Inlet-Shelikof Strait (Lease Sale 60) and Gulf of Alaska/Cook Inlet (Lease Sale 88) (USDOI, BLM, Alaska OCS Office, 1981, and USDOI, MMS, Alaska OCS Region, 1984) FEIS's, hereby incorporated by reference.

Lower Cook Inlet circulation is affected by its location within the Gulf of Alaska. The lower Cook Inlet connects to the Gulf of Alaska through Kennedy and Stevenson Entrances and Shelikof Strait. The generalized regional circulation is shown in the inset in Figure III.A.2-5.

The easterly flowing North Pacific Current divides into the north flowing Alaska Current and the south flowing California Current. The Alaska Current forms an approximately 400-km-wide, offshore, counterclockwise flow, with surface velocities approximately 30 centimeters per second (cm/s) in the eastern Gulf of Alaska. This decreases to < 100 km wide with surface velocities up to 100 cm/s in the western Gulf of Alaska, where the current is named the Alaskan Stream (Reed and Schumacher, 1989). The Alaskan Stream volume transport is 12 to 15 million cubic meters per second (10^6 m^3/s) and shows no significant seasonal variation (Reed, Muench, and Schumacher, 1980; Reed, 1984).

The Alaskan Stream and the Alaska Coastal Current (also called the Kenai Current in some literature) in the northern Gulf of Alaska influence the lower portion of lower Cook Inlet. The Alaska Coastal Current flows along the inner shelf in the western Gulf of Alaska and enters Cook Inlet and Shelikof Strait (Schumacher and Reed,



Source: Macklin, Bond, Walker, 1990

Figure III.A.2-4. Generalized Location of Two Orographic Wind Channels in Cook Inlet and Shelikof Strait.

1980; Royer, 1981). It is a narrow (<30 km), high-speed (20-175 cm/s) flow that is driven by freshwater discharge and inner-shelf winds (Royer, 1981, 1982; Reed and Schumacher, 1989). Peak velocities of 175 cm/s occur in September through October (Johnson, Royer, and Luick, 1988). The Alaska Coastal Current transport volume ranges from 0.1 to 1.2 x 10^6 m^3/s and varies seasonally in response to freshwater runoff fluctuations, regional winds, and atmospheric pressure gradients (Luick, Royer, and Johnson, 1987; Royer, 1981, 1982; Reed, Schumacher, and Incze, 1987; Schumacher and Reed, 1980, 1986; Schumacher, Stabeno, and Roach, 1989). Oxygen isotope measurements in late summer show that glacial meltwater may provide much of the total freshwater runoff into the Alaska Coastal Current (Kipphut, 1990). The Alaska Coastal Current was the dominant transport process affecting oil leaving Prince William Sound during the *Exxon Valdez* oil spill (Galt and Payton, 1990; Galt, Lehr, and Payton, 1991). Oil moved approximately 10 to 13 km per day with the Alaska Coastal Current, which is considered slow, due to the low freshwater discharge in March and April 1989 (Galt, Lehr, and Payton, 1991).

a. Lower Cook Inlet:

(1) **Circulation**: Cook Inlet is a complex Gulf of Alaska estuary. An estuary is defined as a semienclosed coastal body of water having a free connection to the open sea and within which the seawater is measurably diluted with freshwater deriving from land drainage (Cameron and Pritchard, 1963). Cook Inlet has marine connections with Shelikof Strait and the Gulf of Alaska and terrestrial source waters including numerous large rivers and is characterized by estuarine-like circulation (Muench, Mofjeld, and Charnell, 1978).

The generalized lower Cook Inlet mean circulation is shown in Figure III.A.2-5. A southward flow along western lower Cook Inlet is due to the coriolis force acting on freshwater entering upper Cook Inlet from rivers (Rosenberg et al., 1967; Gatto, 1976; Muench, Mofjeld, and Charnell, 1978). The three primary rivers are the Susitna, Matanuska, and Knik Rivers with a combined peak discharge of about 90,000 m^3/s that occurs in July through August (Sharma et al., 1974). Northern Cook Inlet salinity, temperature, and suspended-sediment concentrations change significantly with the season and reflect variations in the upper Cook Inlet freshwater input (Sharma et al., 1974).

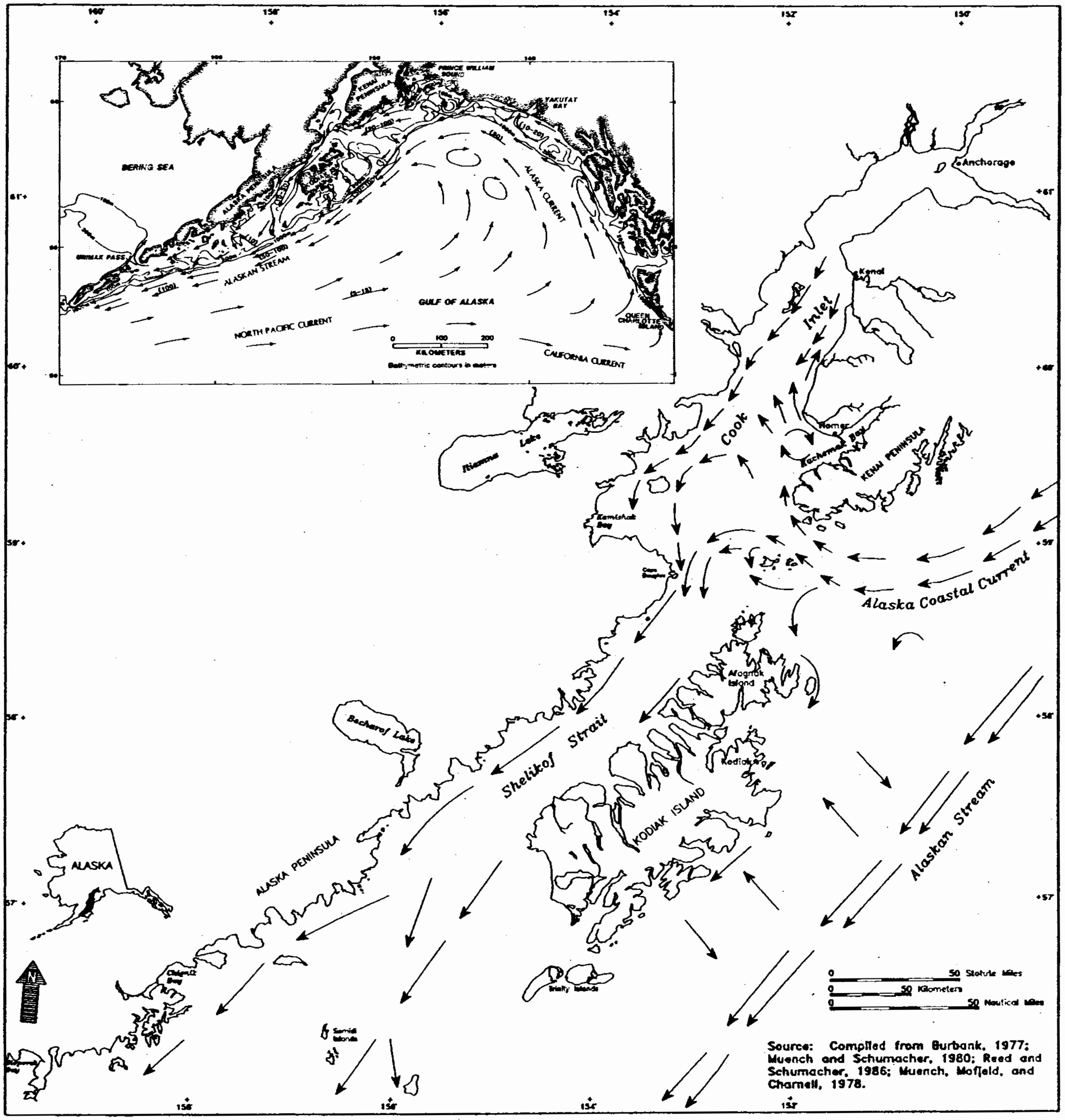
The Alaska Coastal Current and deeper water enter Cook Inlet from the Gulf of Alaska through Kennedy and Stevenson Entrances and flow northward along the eastern side and westward along the 100-m isobath, turning south near Cape Douglas (Sharma et al., 1974; Burbank, 1977; Muench, Mofjeld, and Charnell, 1978; Muench and Schumacher, 1980; Muench, Schumacher, and Pearson, 1981). Westerly mean flow during winter is approximately 20 m/s with south flow approximately 5 to 10 cm/s (Muench and Schumacher, 1980). In summer, westerly flow is slower and southerly flow is faster (Muench and Schumacher, 1980). Surface circulation is controlled by the seasonally varying freshwater outflow, with Alaska Coastal Current water traveling farther north during periods of less freshwater input (Science Applications, Inc., 1979).

The relatively fresh turbid upper Cook Inlet outflow meets and mixes with incoming Alaska Coastal Current water in the central Inlet. This mixture flows along the western Cook Inlet and outflows to Shelikof Strait (Muench and Schumacher, 1980).

The instantaneous current field is characterized by wind-driven currents and tidal currents that vary from prominent (principal lunar component M2, amplitude of 80 cm/s) in the eastern lower inlet to weaker (M2 amplitude of 40 cm/s) in the central and western inlet (Muench and Schumacher, 1980; Isaji and Spaulding, 1987).

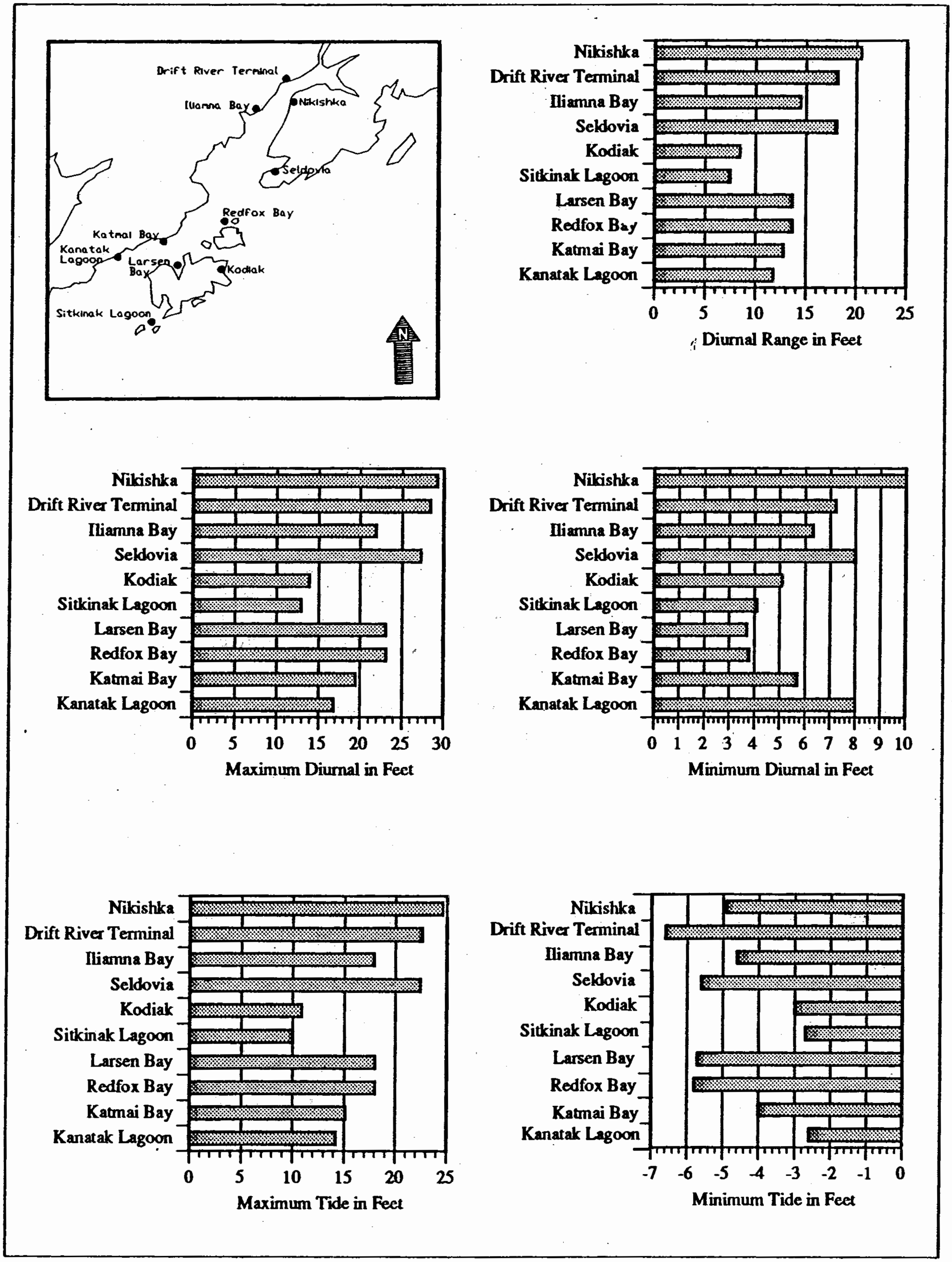
(2) **Tides**: In Cook Inlet, mixed tides are the main surface circulation driving force. Two unequal high and low tides occur per tidal day (24 hours, 50 minutes long), with the mean range increasing northward (Fig. III.A.2-6). Mean diurnal range on the east side is 19.1 feet (ft), while across the channel on the west side it is 16.6 ft (Rosenberg et al., 1967; Science Applications, Inc., 1979; U.S. Dept. of Commerce [USDOC], National Oceanic and Atmospheric Administration [NOAA], National Ocean Survey, 1992). Tidal currents reach 102 to 153 cm/s in the lower Cook Inlet entrance, and speeds >335 cm/s occur at narrows (Mungall, 1972; Gatto, 1976).

(3) **Upwelling/Fronts/Convergences**: Detailed information on localized processes is lacking; specific areas mentioned in the literature are included. Upwelling occurs along the outer Kenai Peninsula coast northwest of the Chugach Islands. The upwelled water enters Kachemak Bay, promoting high productivity (Science Applications, Inc., 1979). Fronts occur as Gulf of Alaska water encounters freshwater outflow from the



Source: Compiled from Burbank, 1977; Muench and Schumacher, 1980; Reed and Schumacher, 1986; Muench, Mofjeld, and Charnell, 1978.

Figure III.A.2-5. Schematic of Mean Spring-Summer Surface Circulation in Lower Cook Inlet/Shelikof Strait Region



Source: Brower et al., 1988.

Figure III.A.2-6 Mean Diurnal Range, Maximum and Minimum Diurnal, and Maximum and Minimum Tide for Representative Tidal Stations in the Cook Inlet/Shelikof Strait Region.

upper Inlet. These zones, termed "rips," are debris-accumulation locations. Burbank (1977) mapped rip locations based on conversations with local fishermen (Fig. III.A.2-7).

(4) Sea Ice: Sea ice, beach ice, stamukhi ice, and river ice are the four ice types in Cook Inlet. Sea ice is most prevalent in the Sale 149 area during winter (LaBelle et al., 1983; Brower et al., 1988).

Sea-ice-observation data are available in data reports (Hutcheon, 1972a,b and 1973; Schulz, 1977a,b,c and 1978; Eaton, 1980; Poole 1980, 1981a,b). In Cook Inlet, the sea-ice amount varies annually. Sea ice generally forms in October-November, gradually increasing from October to February from the West Forelands to Cape Douglas, and melts in March to April (Brower et al., 1988; Fig. III.A.2-8). The primary factor for sea-ice formation in upper Cook Inlet is air temperature, and for lower Cook Inlet it is the Alaska Coastal Current temperature and inflow rate (Poole and Hufford, 1982).

b. Upper Shelikof Strait:

(1) Circulation: The flow in Shelikof Strait is complex and varies over small time and space scales (Reed and Schumacher, 1989). The general circulation pattern is modified locally in response to meteorological conditions. Shelikof Strait has an estuarine-like circulation with deep water from the south flowing north (Reed, Schumacher, and Incze, 1987).

Mean surface circulation through Shelikof Strait generally is to the southwest along the Alaska Peninsula in response to the outflow from Cook Inlet and the inflow of Alaska Coastal Current water from Kennedy Entrance. The southwest flow merges with the Alaskan Stream approximately 200 km southwest of Kodiak (Muench and Schumacher, 1980). The mean flow is variable, with large changes over a few months, weeks, and days. The mean flow variability correlates to freshwater discharge and alongshore winds (Schumacher, Stabeno, and Roach, 1989). Observed flow speeds generally are 20 to 70 cm/s in winter and 5 to 15 cm/s in summer (Schumacher, Stabeno, and Roach, 1989).

Southern and central Shelikof Strait has depths >200 m and an estuarine-like circulation (Reed, Schumacher, and Incze, 1987). Bottom temperature and salinity variations seem to result from intrusion of slope water that moves northward over the strait's southern sill (Reed, Schumacher, and Incze, 1987; Reed and Schumacher, 1989). Southern deepwater sources result from the southern water vertically mixing (Reed, Schumacher, and Incze, 1987).

(2) Tides: In Shelikof Strait, the tide floods from both ends of the strait; the ebb is out of the southwest end. The mean tidal range in Shelikof Strait is 7 to 12 ft (Fig. III.A.2-6).

(3) Upwelling/Downwelling/Fronts/Convergences: Strickland and Sibley (1984) showed that downwelling is clearly indicated in the Shelikof Strait area in winter, with weak upwelling during the summer. A convergence band wraps around Cape Douglas and extends down northern and western Shelikof Strait due to freshwater outflow from Cook Inlet (Galt, Lehr, and Payton, 1991).

(4) Sea Ice: Other than localized freezing in protected bays during particularly cold periods, sea-ice formation in Shelikof Strait has not been observed.

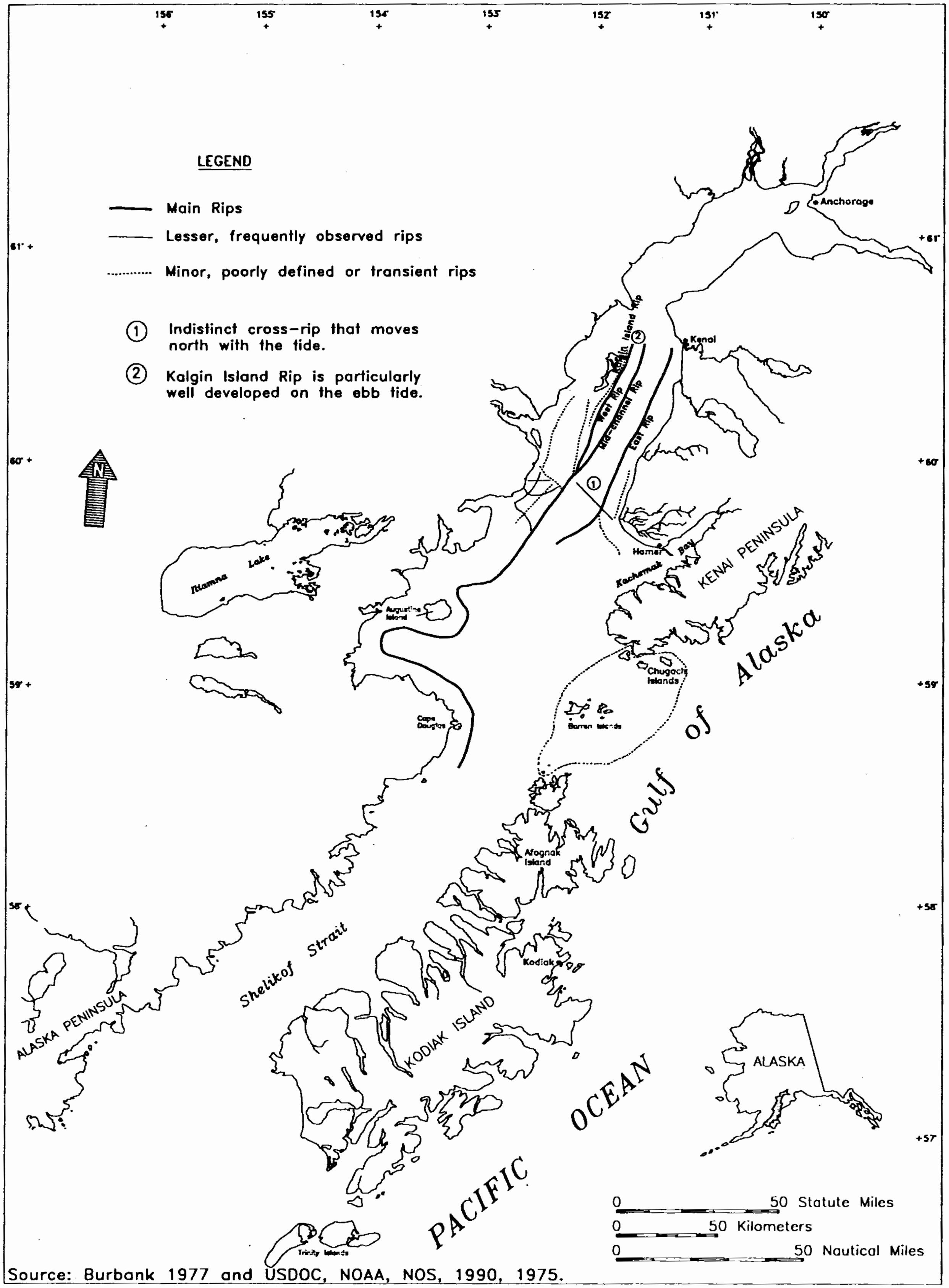
4. Chemical Oceanography:

For this discussion, the planning area is divided into Cook Inlet and upper Shelikof Strait.

a. Cook Inlet:

Cook Inlet waters are influenced by terrestrial and marine water input.

(1) Salinity: During summer and fall, salinity varies from 32‰ at the entrance to lower Cook Inlet to approximately 26‰ at the Forelands (Rosenberg et al., 1967; Kinney, Groves, and Button, 1970; Wright, Sharma, and Burbank, 1973; Gatto, 1976; Feely et al., 1979a; Muench, Mofjeld, and Charnell, 1978). There is a characteristic isohaline (lines of equal salinity) bending resulting from high-salinity water on the eastern side and low-salinity water on the western side of the inlet. The surface salinity contours in lower Cook Inlet are affected by tidal currents.



Source: Burbank 1977 and USDOC, NOAA, NOS, 1990, 1975.

Figure III.A.2-7. Estimated Location of Commonly Observed Tide Rips in Lower Cook Inlet.

(2) **Temperature:** Temperature varies from approximately 11 °C at the entrance to lower Cook Inlet to approximately 10 °C at the Forelands (Rosenberg et al., 1967, Sharma et al., 1974; Kinney, Groves, and Button, 1970; Feely et al., 1979a; Muench, Mofjeld, and Charnell, 1978). Western Cook Inlet water is cooler in the spring and warmer in the fall than incoming oceanic water from the Gulf of Alaska (Feely et al., 1980).

(3) **Suspended Particulate Matter (SPM):** The SPM concentrations range from 100 parts per million (ppm) near the Forelands to 1 to 2 ppm near the inlet entrance. Surface SPM distributions have high horizontal gradients across the inlet. On the western side, SPM loads increase rapidly from 5.0 ppm near Kamishak Bay to >100 ppm north of Tuxedni Bay. On the eastern side, SPM loads range from 0.5 ppm near Cape Elizabeth to 5.0 ppm near Cape Ninilchik (Feely et al., 1980, 1979b). Aluminum silicate minerals from coastal rivers make up 80 to 90 percent of the SPM, with biogenic matter making up the rest. Organic matter of marine and terrestrial origin predominate in the east and west of the inlet, respectively (Feely et al., 1979b).

Cook Inlet SPM can accommodate up to 11 percent of its weight in Cook Inlet crude oil (Feely, Cline, and Massoth, 1978). The preliminary study shows that particle size and chemistry are important as well as the oil chemistry in determining the amount of oil absorbed.

b. **Shelikof Strait:** The chemical oceanography of Shelikof Strait is influenced by the diluted seawater flow from Cook Inlet and the inflow of the Alaska Coastal Current into Shelikof Strait primarily through Kennedy Entrance.

(1) **Salinity:** Surface salinity is at a maximum in February and at a minimum in October (Reed and Schumacher, 1989). Surface water along the Peninsula side is more dilute due to discharge from lower Cook Inlet. The middle strait has salinities <32‰ similar to Kennedy Entrance. Saline water, >32‰, exists in deeper portions of the Strait (Kim, 1986).

(2) **Temperature:** Surface temperatures reach a minimum in March and a maximum in August. There is no seasonal change for subsurface temperatures (Reed and Schumacher, 1989). In Shelikof Strait, the surface water along the Peninsula side is colder than water near Kodiak Island due to the discharge from lower Cook Inlet (Kim, 1986). Waters in the central Shelikof Strait have similar temperatures to waters in Kennedy Entrance (approximately 5 °C in March; Kim, 1986). Warmer water, >5 °C, occupies deeper portions of the Strait between Kodiak Island and the peninsula (Kim, 1986).

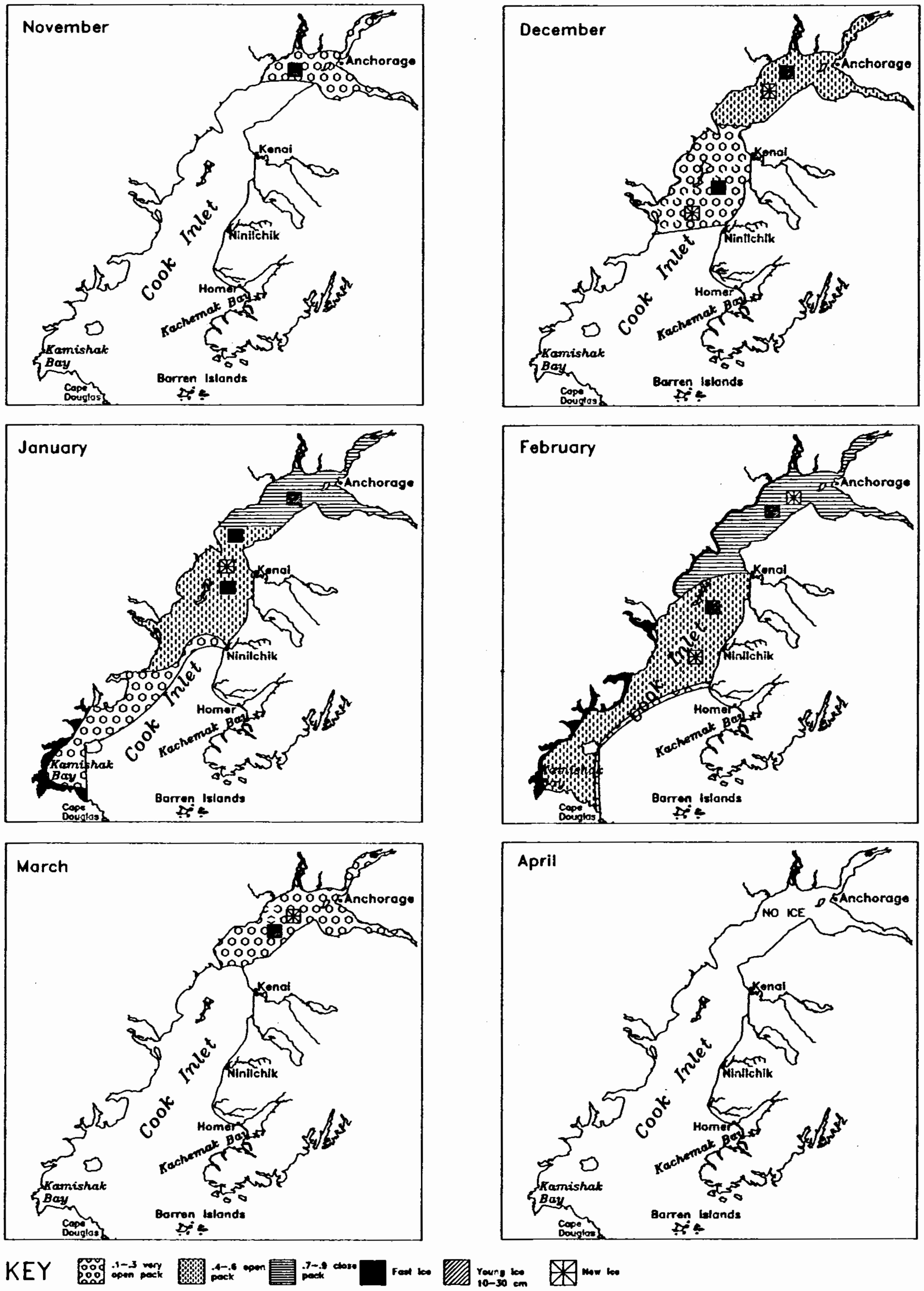
(3) **Suspended Particulate Matter:** Surface SPM in Shelikof Strait ranges from 1.0 to 5.0 ppm. The cross-channel gradients in Shelikof Strait indicate that Cook Inlet acts as a conduit transporting SPM south where it mixes with oceanic water (Feely et al., 1980).

5. Water Quality:

a. **Introduction:** The marine waters of Cook Inlet/Shelikof Strait (CI/SS) provide an environment for (1) many species of pelagic and benthic plants and animals and (2) a variety of humankind's commercial, industrial, subsistence, and recreational activities.

The quality of the CI/SS aquatic environment is determined by water's physical and chemical characteristics—Sections III.A.3 and III.A.4 (Physical Oceanography and Chemical Oceanography, respectively). The constituents of the waters mainly are composed of naturally occurring substances but also include manmade substances—pollutants. The naturally occurring substances are derived from the atmospheric, terrestrial, and other aquatic (fresh and marine) environments. The waterborne and airborne substances entering CI/SS waters also may include pollutants.

Naturally occurring and pollutant substances entering the CI/SS waters are diluted and dispersed by the currents associated with the tides, estuarine circulation, wind-driven waves and currents, and coriolis force (Sec. III.A.3). However, some of the persistent pollutants may accumulate in (1) the food chain and exceed toxic thresholds, particularly in predators near the top of the food chain, or (2) the seafloor sediments.



Source: Brower et al., 1988.

Figure III.A.2–8. Generalized Location of Sea Ice in Cook Inlet, November–April.

b. **Stream Discharges and Marine Water Input:** The mean annual volume of freshwater discharged by streams flowing into Cook Inlet exceeds 18.5 trillion gallons (Table III.A.5-1); this volume probably is low because the discharge rates of a number of streams, particularly along the western side of Cook Inlet, have not been measured. About 80 percent of this discharge is supplied by the Knik, Matanuska, and Susitna Rivers. In general, discharge rates are low in November through March; begin to rise in April; peak in June, July, or August; and decline in September and October. For the Knik, Matanuska, and Susitna Rivers, the mean monthly discharge rates in November through March range from about 2 to 9 percent of the peak discharge rates in June or July (Freethey and Scully, 1980).

Many of the streams flowing into Cook Inlet are glacial fed and contain high concentrations of SPM (Table III.A.5-1). An estimated 99 percent of the annual SPM load is carried by the streams during the period from May through October (Parks and Madison, 1985). Based on the mean discharge rates for the Knik, Matanuska, and Susitna Rivers, the mean annual discharge of SPM into Cook Inlet probably exceeds 80,123 million pounds [lb] per year (about 40 million tons/year).

A variety of metals enters Cook Inlet in the stream discharges. Table III.A.5-2 shows the concentrations of some of the metals in stream and lake sediments of the Cook Inlet region and Table III.A.5-3 shows the concentrations in some of the streams and rivers. Zinc also occurs in the discharges from point sources of pollution and is the only metal whose concentration was required to be reported in two of the principal pollutant discharges reported in Section III.A.5.d(2); these are the discharges from the Municipality of Anchorage Point Woronzof Wastewater Treatment Facility and the produced waters from offshore petroleum production operations. The amount of zinc discharged into the Cook Inlet by the streams can be estimated, perhaps within an order of magnitude, from data for the Susitna River (at Gold Creek), which indicates a mean discharge rate of 9,970 cubic feet per second (ft^3/s) (Table III.A.5-1) and a zinc concentration of about 10 micrograms per liter ($\mu g/l$) (reported as dissolved) (Table III.A.5-3). Based on this information, the amount of zinc that streams contribute to Cook Inlet probably exceeds 196,300 lb/year (about 98 tons/year); the mean discharge rate for the Susitna River at Gold Creek is about 20 percent of the rate at Susitna Station and about 13 percent of mean annual discharge shown in Table III.A.5-1. The minimum and maximum mean discharge rates from the Susitna River (at Gold Creek) have ranged from 5,597 to 13,020 ft^3/s (Lamke et al., 1991), respectively. At these discharge rates for the Susitna River (at Gold Creek), the amount of dissolved zinc discharged into Cook Inlet might range from at least 110,200 to 256,350 lb/year (about 55-128 tons/year).

Other metals in the streams and rivers discharging into Cook Inlet that are part of the various municipal and industrial discharges include barium (Ba), mercury (Hg), and cadmium (Cd). Barium is the major component of drilling muds (barium comprises about 59% of the mineral barite [barium sulphate], which constitutes about 63% of the drilling muds). As shown in Tables III.A.5-2 and III.A.5-3, barium naturally occurs in the stream and lake sediments of the Cook Inlet region and in the streams. (The solubility of barium sulphate in cold, freshwater is about 0.00222 grams per liter [g/l], which is quite low when compared to the solubility of salt [NaCl]—357 g/l.) Mercury and cadmium are found in barite, and mercury is one of the metals whose concentration in the municipal wastewater effluent is reported. As noted above with zinc, the amounts of these metals discharged into Cook Inlet can be estimated, perhaps within an order of magnitude, from data for the Susitna River (at Gold Creek); as noted above, the mean discharge is about 9,970 ft^3/s but could range from 5,597 to 13,200 ft^3/s. From Table III.A.5-3, the concentration of dissolved (1) barium might range from 27 to 38 $\mu g/l$, (2) mercury is <0.1 $\mu g/l$, and (3) cadmium might range from <1 to 30 $\mu g/l$. Based on these concentrations and the discharge range, the amount of (1) barium discharged might range from about 298,000 to 974,000 lb/year (149-487 tons/year), (2) mercury from <1,102 to <2,563 lb/year, and (3) cadmium from <11,018 to 779,690 lb/year.

The streams and rivers draining into Cook Inlet also carry hydrocarbons. Part of these carbon compounds are biogenic and part comes from the erosion of sedimentary rocks that may contain hydrocarbon compounds, and coal deposits are found throughout the Cook Inlet region. In all sedimentary rocks, about 3 percent of the organic matter is converted to hydrocarbons with 15 or more C (carbon) atoms and practically all shales and carbonate rocks contain liquid hydrocarbons that are comparable to reservoir oils (Hunt, 1979). Coal contains substances derived from plant resins, waxes, and fats and oils and includes aliphatic and aromatic compounds (Schobert, 1990). The amount of carbon streams and rivers transport into Cook Inlet is estimated to be at least 39,000 tons per year. This is a low-range estimate, because it is based on the amount of dissolved carbon in the Susitna River (at Gold Creek) in June, July, and August of 1985 (Still et al., 1985); this amount is assumed to be 4 milligrams per liter [mg/l].

Table III.A.5-1
Summary of Data for Streams and Rivers Flowing into Cook Inlet

Discharge Area and Stream or River	Mean Annual Discharge (ft^3/sec)	Mean Discharge May to October (ft^3/sec)	Mean Suspended Sediment Concentration May to October (mg/L)	Mean Suspended Sediment Discharge May to October (tons/day)	Drainage Area (miles^2)	Percent of Drainage Area Covered by Glaciers	Stream Length (miles)
Knik Arm							
Knik River (near Palmer)	6,784	12,309	1,130	37,500	1,180	54	43
Matanuska River (near Palmer)	3,869	7,088	1,564	29,900	2,070	12	77
Peters Creek (near Birchwood)	121				87.8		
Eagle River (at Eagle River)	499	911	128	315	192		19
Ship Creek (near Anchorage)	164				90.5		19
Chester Creek (at Arctic Blvd)	19				27.2	0	12.8
Turnagain Arm							
Campbell Creek (near Spenard	67				69.7	0	19.2
Glacier Creek (at Girdwood)	252				62	11	11
Portage Creek (at lake outlet)	847				40.5		
Resurrection Creek (near Hope)	243				149	0	19.8
Cook Inlet (east side)							
Kenai River	5,939				2,101	11	118
Kasilof River (near Kasilof)	2,368				738	28	21
Ninilchik (at Ninilchik)	121	128	58	20	131	0	55
Anchor River (at Anchor Point)	289				226	0	28
Kachemak Bay							
Bradley River (near Homer)	408				54	36	13.3
Seldovia River (near Seldovia)	205				26.2		
Barabara Creek (near Seldovia)	106				20.7		
Cook Inlet (west side)							
Paint River (near Kamishak)	1,291				205		
Chuitna River (near Tyonek)	341				131		
Chakachatna River (at Tyonek)	3,617				1,120	30	54.5
Susitna River (at Gold Creek)	9,970	19,300	796	41,260	6,160	5	189
Susitna River (at Susitna Station)	50,740						
Little Susitna River (near Palmer)	209				61.9	5	14.5
Totals	78,499[1]			108,660[2]	14,943.5[3]		

Sources: Bigelow et al., 1984; Freethey and Scully, 1980; Lamke et al., 1982, 1990, 1991; Still et al., 1983, 1985; USGS, 1981, 1980, 1979, 1978, 1977, 1976, 1975, 1974, 1966, 1965, 1964; Vaill et al., 1987; Van Maanen et al., 1986.

[1] Susitna River at Susitna Station (18,519,548,000,000 gal/year—18.52 trillion gal/year).

[2] Sediment Discharge for Knik River, Matanuska River, and Susitna River (at Gold Creek) (79,322,000,000 lb/year).

[3] Cook Inlet Basin ~ 38,000 mi^2 (Freethey and Scully, 1980). Estimated drainage area ~ 20,000 mi^2 (Balding, 1976).

Table III.A.5-2

Trace and Other Metals in River and Lake Sediments of the Terrestrial Environment Surrounding Cook Inlet

Metals	Approximate Concentration Range (ppm) Los Alamos National Laboratory[1] From	 To	 Jasper[2] From	 To
Aluminum	<26,710	84,430	---	---
Barium	<383	1,158	---	---
Chromium	<47	84	---	---
Cobalt	<7	>60	---	---
Copper	<16	>120	0	39
Iron	<15,900	>109,800	---	---
Lead	5	>50	0	100
Magnesium	<5,262	38,004	---	---
Manganese	236	1,700	---	---
Molybdenum	---	---	0	56
Nickel	<19	58	0	16
Uranium	<2.0	---	---	---
Zinc	<77	288	0	27

Sources: [1] Los Alamos National Laboratory, 1983.
[2] Jasper, 1967.

Table III.A.5-3
Metal Concentrations in Cook Inlet Streams and Rivers

Streams Sample Date	Metals (Reported as Dissolved, Total , or *Total Recoverable*)																										
	Ca	Mg	Na	K	P	Al	As	Ba	Be	Cd	Cr	Co	Cu	Fe	Pb	Li	Mn	Hg	Mo	Ni	Se	Ag	Sr	Va	Zn	Ra^{226}	Ur
	mg/l					µg/l																				pCi/l	µg/l
Willow Creek (at Hatcher Pass Road near Willow)																											
Oct 05, 1978	10	2.4	7.7	0.8	0.00	*50*	3	*0*		*0*	*0*		*3*	110	*1*		40	*0.0*		*1*	0	*0*	*0*				
Talkeetna River (near Talkeetna)																											
Mar 22, 1991	25	2.7	15	1.6	<.010	<10	<1	18	<0.5	<1.0	2	<3	1	15	<1	18	5	<0.1	<10	2	<1	<1.0	140	<6	6	0.03	0.13
Jul 19, 1991	15	1.8	4.3	0.70	<.010	80	1	23	0.5	1.0	<1	<3	1	35	<1	8	4	<0.1	<10	3	<1	<1.0	78	<6	9	0.03	0.12
Jan 24, 1990	17	2.4	10	1.1	<.010	<10	<1	15	<0.5	<1.0	<1	<3	<10	18	<10	14	4	<0.1	<10	<10	<1	<1.0	120	<6	3	0.10	0.14
May 15, 1990	12	1.5	4.2	0.70	<.010	30	8	10	<0.5	<1.0	<1	<3	2	39	<1	5	4	<0.1	<10	<1	<1	<1.0	62	<6	5	--	--
Jun 28, 1990	13	1.5	3.5	0.70	<.010	30	<1	10	<0.5	5.0	<1	<3	3	13	1	5	4	<0.1	<10	1	<1	<1.0	58	<6	9	0.08	0.07
Aug 14, 1990	13	1.4	3.4	0.70	<.010	100	<1	18	<0.5	<1.0	1	<3	2	54	<1	4	10	<0.1	<10	<1	<1	<1.0	79	<6	<3	--	--
Susitna River (at Gold Creek)																											
Jul 24, 1985	18	2.2	3.9	1.8	0.010		<1	38		<1 *2*	<10	<1	2	320 *14000*	<1 *<1*		<1	<.1		<1	<1	<1			13 *60*		
Aug 28, 1985	19	2.6	5.0	1.6	<.010		<1	27		20 *30*	<10	<1	3	120 *4700*	<1 *6*		6	<.1		3	<1	<1			14 *40*		
Jan 30, 1982	22	3.0	4.3	1.2	--		1	<100		1 *<1*	<10	<1	2	30 *10*	1 *1*		10	<.1		<1	<1	1			10 *10*		
Mar 30, 1982	19	2.6	2.2	1.1	0.010		0	29		<3 *<1*	<10	<1	1	15 *30*	<1 *6*		4	<.1		1	1	<1			12 *30*		
Jun 23, 1981	23	2.7	2.5	1.0	0.010		1	0		0	0	0	2	60	0		0	0		1	1	0			10		
Sep 29, 1981	24	3.0	3.0	1.1	<.010		1	0		0	0	0	2	10	3		10	0		0	1	0			0		
Eagle River (near Eagle River)																											
Oct 23, 1980	31	4.2	3.3	0.4	.030		2	20		2	0		4	30	2		50	.0			0	0			5		
Chester Creek (near 36th Ave. Anchorage)																											
Mar 07, 1984	30	1.8	180	3.3		*53000*				*10*				*86000*	*690*										*1400*		
Mar 14, 1984	42	1.2	82	3.2		*32000*				*<10*				*51000*	*940*										*750*		
Campbell Creek (near Spenard)																											
Apr 23, 1986							2		*<10*	*1*	*7*		*62*	*4400*						*<1*		*<1*			*170*		
Sep 08, 1986							1		*<10*	*<1*	*4*		*4*	*2300*						*<1*		*<1*			*60*		
Glacier Creek (at Girdword)																											
Jun 13, 1985	13	1.5	1.4	.20	<.010									21			4										
Deep Creek (near Ninilchik)																											
Mar 12, 1979	6.5	3.9	4.4	1.4	0.02									310			60										
May 14, 1979	5.2	1.5	2.1	0.6	0.02									190			20										
Drift River (near Redoubt Volcano)																											
Apr 25, 1990	46	5.0	8.4	1.8										8			950										

Sources: Bigelow et al., 1984; Lamke et al.,1982, 1991, 1990; Still et al., 1985; USGS, 1981, 1979, 1978; Van Maanen et al., 1986.

Estimates of the amount of zinc, barium, mercury, cadmium, and carbon that might be discharged into Cook Inlet probably are at the low end of a possible range. The estimates are based on values at Gold Creek along the Susitna River. As noted in Table III.A.5-1, the mean annual discharge of the Susitna River (at Gold Creek) is 9,970 ft^3/s; this amount is about 13 percent of the total mean annual discharge of the streams and rivers listed in that table.

As noted in Section III.A.3, marine water (a mixture of seawater, glacier meltwater, and freshwater runoff) from the Alaska Coastal Current (ACC) enters Cook Inlet through the Kennedy and Stevenson Entrances. The volume of water transported by this current varies and ranges from 0.1 to 1.2 million m^3/s; 0.1 million m^3/s is equivalent to 3,531,000 ft^3/s, which is about 45 times greater than the mean annual freshwater discharge (78,499 ft^3/s—Table III.A.5-1) entering the inlet. In response to the general counterclockwise circulation, part of the water from the ACC would flow northward along the eastern side of lower Cook Inlet before crossing the inlet and flowing southward into Shelikof Strait. In Kennedy Entrance, the southern part of lower Cook Inlet, and the northern part of Shelikof Strait, the mean transport for March and October of 1985 was 0.14 and 0.27 m^3/s, respectively (Reed, Schumacher, and Incze, 1987). As these volumes are near the low end of the range noted above and during the times of the year when freshwater input to the marine environment is low, it is assumed they represent a possible volume range of ACC water that circulates in lower Cook Inlet. Rates of 0.14 and 0.27 m^3/s would transport about 1,664.45 and 2,249.59 trillion gallons annually.

c. Constituents of the Marine Environment:

(1) **Salinity and Temperature:** Information on the salinities and temperatures of the waters of CI/SS are presented in Section III.A.4.

(2) **Oxygen, Phosphate, Nitrate, Nitrite, Ammonia, and Silicate in the Water Column:** The concentration of oxygen in the surface waters of Cook Inlet ranges from about 7.6 milliliters per liter (ml/l) in the northern part to 10 ml/l in the southwestern part; none of the waters in the inlet are oxygen deficient (Kinney, Groves, and Button, 1970). The concentration ranges of other chemical parameters included phosphate 0.31 to 2.34 $\mu g/l$, nitrate 0 to 23.5 $\mu g/l$, nitrite 0.02 to 0.52 $\mu g/l$, ammonia 0.2 to 3.1 $\mu g/l$, and silicate 9 to 90 $\mu g/l$ (Kinney, Groves, and Button, 1970). In general, the concentration of phosphate increases toward the mouth of Cook Inlet while the concentrations of nitrate and silicate decrease; the silicate concentration appears to be directly related to the suspended-sediment load (Kinney, Groves, and Button, 1970).

(3) **Suspended Particulate Matter:** The principal sources of SPM in Cook Inlet are the Matanuska, Knik, Susitna, and Beluga Rivers, all of which discharge into upper Cook Inlet; these rivers supply about 70 to 80 percent of the freshwater input to Cook Inlet and between 75 and 90 percent of the suspended sediment (Feely and Massoth, 1982).

The elemental composition of SPM from (1) the mouths of the Susitna, Matanuska, and Knik Rivers and (2) lower Cook Inlet are summarized in Table III.A.5-4. Aluminum, calcium, iron, and magnesium are present in relatively high concentrations (>1% by weight or >10,000 ppm); manganese occurs in intermediate concentrations (about 1,000 ppm); and copper, lead, chromium, nickel, and zinc are found in lower concentrations (<200 ppm). Feely et al. (1981) note that within the statistical limits of the measurements, the samples from lower Cook Inlet have very nearly the same major elemental composition as do the samples from the rivers. However, the composition of SPM in the southeastern part of Cook Inlet (the outer part of Kachemak Bay and the Kennedy and Stevenson Entrances) indicates these particles principally came from the Copper River (Feely et al., 1981) and were transported westward by the ACC.

The elemental metal concentrations in the SPM sampled in 1993 (University of Alaska, Anchorage [UAA], Environmental and Natural Resources Institute [ENRI], 1995) also shown in Table III.A.5-4. For those elements (chromium, copper, iron, lead, nickel, and zinc) analyzed in both studies, the concentrations reported in the ENRI (1995) study for samples taken in June were similar to those reported by Feely and Massoth (1982). Iron was present in relatively high concentrations (about 15,000-50,000 $\mu g/l$) for most of the 1993 stations sampled in early summer (June 20-28) (Table III.A.5-4), and copper, lead, chromium, nickel, and zinc were present in lower concentrations (generally <200 $\mu g/g$). In the 1993 suspended-sediment samples, the concentrations of other metals also were determined and these included antimony, arsenic, barium, cadmium, mercury, nickel, silver, titanium, vanadium, and zinc; concentrations of these elements are shown in Table III.A.5-4. Table III.A.5-4 also shows the abundance of the elements in the earth's crust. The SPM discharged by the rivers into Cook Inlet is

Table III.5-4
Summary of the Elemental Composition of Suspended Particulate Matter

Elements	Rivers[1] (Susitna, Matanuska, and Knik -- June 1977) (ppm or *percent)*	Upper Cook Inlet[2] (1993) (μg/l)		Lower Cook Inlet				Abundance of Elements in the Earth's Crust[3] (ppm or *percent)*
				(June 1977)[1] (ppm or *percent)*		(1993)[2] (μg/l)		
		June	August	April	July	June	August	
Aluminum	*8.57-12.90*	---	---	*3.64 ± 1.6*	*6.98 ± 4.24*	---	---	*8.23*
Antimony	---	0.7-8.2	0.9-1.5	---	---	<0.1-1	<0.1	0.2
Arsenic	---	1.1-9.3	0.2-2.4	---	---	2-10	<0.1-0.1	1.8
Barium	---	423-766	43-293	---	---	26-535	<0.1-9	425
Cadmium	---	0.2-1.4	<0.1-0.4	---	---	<1-61	<0.1-0.3	0.15
Calcium	*1.33-2.37*	---	---	*2.20 ± 0.04*	*1.84 ± 0.63*	---	---	*4.14*
Chromium	112-182	47-108	4-38	95 ± 15	99 ± 30	29-90	0.3-2	102
Copper	49-71	47-94	6-28	75 ± 15	99 ± 33	40-230	0.3-2	60
Iron	*6.07-6.90*	25,200-50,100	3,600-11,900	*6.22 ± 1.0*	*5.14 ± 2.11*	1,800-29,400	11-559	*5.63*
Lead	25-56	15-108	2-31	56 ± 13	65 ± 19	17-388	<0.3-2	14
Magnesium	*3.02-4.30*	---	---	*3.54 ± 0.6*	*2.86 ± 1.41*	---	---	*2.33*
Manganese	1,157-1,308	---	---	1,313 ± 113	1,138 ± 574	---	---	950
Mercury	---	<0.1-0.3	<0.1	---	---	0.1-0.4	<0.1	0.085
Nickel	43-94	35-56	3-20	61 ± 10	70 ± 25	21-48	0.1-0.9	84
Silver	---	0.1-0.3	<0.1	---	---	<0.1-0.2	<0.1	0.075
Titanium	---	0.4-0.7	<0.1-0.2	---	---	0.3-.0.9	<0.1	5,650
Vanadium	---	112-143	11-58	---	---	9-111	<0.1-2	120
Zinc	106-186	110-290	11-83	165 ± 32	352 ± 158	132-1,220	1-6	70

1. Feely et al., 1981.
2. UAA, ENRI, 1995.
3. Fairbridge, 1972.

derived from the erosion of a variety of igneous, sedimentary, and metamorphic rocks surrounding the inlet. For samples collected in June and July, the elemental composition of the SPM generally is similar to that of the crustal composition. However, the concentrations of the elements in the SPM samples collected in April or August generally are lower than they are in June and July samples. Peak discharges of Cook Inlet rivers usually occurs in June or July and, during this time, the suspended-sediment loads of the rivers would be greater than at other times of the year. The high concentration of elements in the June and July samples probably indicates the influence the large SPM loads carried by the river have on character of Cook Inlet SPM. The concentration of titanium in the SPM is several orders of magnitude lower than it is in the crust.

For the June 1993 samples, the concentration of some of the metals in the suspended sediment for a site off the southwestern end of the Kenai Peninsula were different than those from the other Cook Inlet sites. The concentration of iron (1,780-2,220 μg/g) and barium (26-41 μg/g) were less and lead (162-388 μg/g) and zinc (297-1,220 μg/g) were greater than at the other sites. These differences probably represent the influence of Gulf of Alaska waters flowing into Cook Inlet.

The distribution of SPM in CI/SS shows horizontal gradients in both the longitudinal and cross-inlet directions (Feely and Massoth, 1982). The SPM concentration ranges are (1) about 800 to 1,600 mg/l (Table III.A.5-1) in the Knik, Susitna, and Matanuska Rivers from May through October; (2) 1,000 mg/l in the northeastern end of upper Cook Inlet to about 100 mg/l north of the Forelands (Sharma, 1979); and (3) >50 mg/l south of the Forelands to 1 to 5 mg/l in Shelikof Strait (Feely and Massoth, 1982). Along the eastern side of Cook Inlet, the concentrations are low, ranging from 0.5 mg/l near the southwestern end of the Kenai Peninsula to about 5 mg/l north of Cape Ninilchik. The SPM concentrations on the western side of Cook Inlet range from >100 mg/l north of Tuxedni Bay to about 5 mg/l in the vicinity of Kamishak Bay.

The SPM distribution in Cook Inlet is affected by the tidal currents, estuarine and embayment circulation regimes, meteorologic events (winds), wind-generated waves and surface currents, coriolis force, and inlet shape and bathymetry (Hampton et al., 1986; Muench, Mofjeld, and Charnall, 1978; Burrell and Hood, 1967). Tidal currents are the dominant factor affecting the distribution. These phenomena produce considerable turbulence and crosscurrents in the water column during both ebb and flood tides (Burrell and Hood, 1967, as reported in Gatto, 1976). The cumulative effects of dynamic processes and the similarity of SPM concentrations, as well as salinities and temperatures, at the surface and near the bottom, suggest the water column in lower Cook Inlet generally is vertically well mixed (Hampton, et al., 1986; Gatto, 1976; Sharma, 1979); stratified watermasses occur near the entrance to the inlet (Sharma, 1979), and very poorly developed stratification may develop during peak river discharge (Gatto, 1976). For more information on the circulation, tides, and other features associated with the physical oceanography of CI/SS, see Section III.A.3.

The major regions of deposition of the SPM, in order of decreasing importance, are Shelikof Strait, Kamishak Bay, and Kachemak Bay (Feely et al., 1981). In the central part of lower Cook Inlet, the seafloor sediments primarily consist of unconsolidated coarse-grained sands and gravels deposited during the retreat of the Pleistocene glaciers (Bouma and Hampton, 1976, as reported in Feely et al., 1981); these sediments indicate a nondepositional environment, especially for SPM in the water column.

The concentration of SPM in Shelikof Strait ranges from 0.3 to 2 mg/l (Hampton et al., 1986). The SPM, temperature, and salinity characteristics of the strait show evidence of cross-channel gradients similar to those in lower Cook Inlet (Hampton et al., 1986). These similarities suggest the processes affecting the characteristics of the water in lower Cook Inlet also are occurring in Shelikof Strait. The net movement of water and SPM in the strait is to the southwest.

The surficial sediments in the central part of Shelikof Strait are derived mainly from Cook Inlet (Hampton et al., 1986). In the northeastern part of the strait, the sediment accumulation rates are about 10 cm per 100 years. In the southwestern part, sediment is accumulating more rapidly, up to 120 cm per 100 years, in the depressions in the seafloor. Most of the sediments from the Alaska Peninsula and Kodiak/Afognak Island group are deposited behind the sills at the mouths of the fjords.

(4) Hydrocarbons in the Marine Environment:

(a) **Sources:** Some of the hydrocarbons found in the Cook Inlet marine environment may be derived from terrestrial and marine plants and animals. Petroleum and coal hydrocarbons in the environment may be derived from natural sources, activities associated with the exploitation of petroleum resources, and municipal wastewater discharges. Natural oil seeps have been reported from various sites along the western side of CI/SS in an area that extends from Tyonek in the north to Wide Bay in the south (Becker and Manen, 1988). Cook Inlet is part of the Cook Inlet-Susitna coal province that includes the Susitna and Matanuska Valleys, the western side of the Kenai Peninsula, and Cook Inlet north of Augustine Island (State of Alaska, Dept. of Natural Resources, [DNR], 1990). Coal particles are transported to the marine environment as the result of river and coastal erosion processes. A number of studies have been conducted to characterize the hydrocarbons in Cook Inlet and Shelikof Strait.

(b) Environmental Studies:

1) **Outer Continental Shelf Environmental Assessment Program:** In the late 1970's, Minerals Management Service (MMS) sponsored several studies through the Outer Continental Shelf Environmental Assessment Program (OCSEAP). Most of the hydrocarbons detected in the waters, SPM, seafloor sediments, and intertidal biota of CI/SS in the late 1970's were of recent biogenic origin (Shaw, 1981; Katz and Cline, 1981; Kaplan et al., 1980; and Venkatesan and Kaplan, 1982). Terrestrial bacteria and plants and marine bacteria, phytoplankton, and zooplankton produce a variety of organic compounds that includes the lipids (oils), fats, waxes, terpenes, and hydrocarbons.

Hydrocarbon compounds from high temperature and incomplete combustion sources (forest fires and/or the burning of fossil fuels) also were found in the sediments (Kaplan et al., 1980; Venkatesan and Kaplan, 1982). Although the samples were collected and analyzed between 1976 and 1979, the data they provide contribute to (1) the background information on the types, amount, and sources of hydrocarbon compounds in the environment and (2) a historical perspective regarding the possible fate of petroleum hydrocarbons entering the marine environment up to the time of sampling. The succeeding paragraph summarizes crude-oil and produced-water production and oil spills in relation to the 1976 to 1979 study period.

From the 1960's to the end of 1992, approximately 933 million barrels (MMbbl) of oil and 563 MMbbl of water were produced principally from four offshore oil fields in upper Cook Inlet (State of Alaska, AOGCC, 1992). Peak production from these fields occurred in 1970 when about 70 MMbbl of oil were produced. At the end of 1975, about 514 MMbbl of oil and 61 MMbbl of water had been produced—about 55 percent of the total amount of oil and 11 percent of the total amount of water produced from the offshore platforms through 1992 (State of Alaska, DNR, 1969; 1970; 1971; 1972; 1973; 1974; 1975). From 1976 through 1979, the upper Cook Inlet oil fields produced an additional 188 MMbbl of oil and 87 MMbbl of water (State of Alaska, DNR, 1976, 1977; State of Alaska, AOGCC, 1978, 1979). As noted in Section III.A.5.d(4), about 21,000 barrels (bbl) of oil were spilled in Cook Inlet between 1965 and 1975 and about 10,000 bbl from 1976 to 1979.

2) **Cook Inlet Regional Citizens Advisory Council (CIRCAC):** In June and July 1993, CIRCAC conducted a pilot study to determine the (1) total and polynuclear aromatic hydrocarbon (PAH) concentrations and toxicity of subtidal sediments from four areas in Cook Inlet, (2) the physiological condition of a benthic organism in the sediments from the four areas, and (3) if bioavailable petroleum hydrocarbons were present in the water column at two sites in upper Cook Inlet (Hyland et al., 1995). The sediment-sampling sites were located (1) off the mouth of the Beluga River, (2) in Trading Bay off the mouth of the Drift48 River, (3) in Kamishak Bay off the mouth of Bruin Bay, and (4) in Kachemak Bay between Glacier Spit and Bear Cove. Samples were collected from three randomly selected sites in each of the four areas; water depths ranged from about 7 to 17 m. Sediment toxicities were measured with the marine amphipod *Ampelisca abdita* and the benthic organism was the clam *Macoma* spp. The bioavailability of petroleum hydrocarbons in the water column was determined by using mussels (*Mytilus edulis*) confined in suspended cages that were deployed for 1 month at two locations; one site was located in the sediment-sampling area near the mouth of the Beluga River, and the other site was located near a suspected source of petroleum hydrocarbons from a produced-water outfall in Trading Bay. *Macoma* spp. were found in the Kamishak and Kachemak Bays sampling areas but not in the samples from the Beluga River and Trading Bay areas. The distribution of PAH's in most of the samples indicated these hydrocarbons were derived from petrogenic, pyrogenic, and diagenetic sources (Hyland et al., 1995).

3) **University of Alaska, Anchorage Environmental and Natural Resources Institute (UAA, ENRI)**: During the summer of 1993, UAA, ENRI, through a cooperative agreement with MMS, conducted an investigation to establish baseline information on the occurrence of petroleum hydrocarbons and trace metals in Cook Inlet (UAA, ENRI, 1995). The sampling and analysis program included the collection of seawater, sediments, and biota for chemical analysis and bioassays. The analyses included hydrocarbons and trace metals in water, biota, and sediments and water and sediment bioassays. Sampling locations included sites in bays where fine-grained sediments indicate a depositional environment, in the vicinity of production platforms in upper Cook Inlet and the processing and transportation facilities in the northern part of lower Cook Inlet, and sites previously sampled between 1976 and 1979. The number of stations sampled ranged from 6 to 15; replicate samples were taken at all stations. Toxicity analyses included Microtox® bioassays using luminescent bacteria, 10-day solid-phase static test with the amphipod *Rhepoxynius abronius*, liquid-phase sperm-cell test with the sand dollar *Dendraster excentricus*, and a 48-hour receiving water larval test with *D. excentricus*.

4) **Marathon Oil Company**: In November 1993, Marathon Oil Company sampled the waters of Trading Bay north, east, and south of the Trading Bay Treatment Facility discharge-pipe outfall for hydrocarbons (Neff and Douglas, 1994); the outfall is located about 1.71 nautical miles (nmi) offshore in waters about 10 m deep. Samples (29 total) were collected within several hours of the slack tide 50, 300, and 750 m from the outfall at depths of 1 m below the surface and 1 m above the bottom; water depths at the sample sites ranged from 33 to 60 ft. The water samples were analyzed for total petroleum hydrocarbons; individual alkanes (C8 through C40); total and individual PAH's; and monocyclic, volatile aromatic hydrocarbons (benzene, toluene, ethylbenzene, and xylene [BTEX]). The hydrocarbon content of two samples from treated produced waters also was determined.

(c) Hydrocarbons in the Water Column:

1) **Total Hydrocarbons**: The total hydrocarbon content of lower Cook Inlet seawater, based on analyzing unfiltered surface seawater samples, ranged from 0.2 to 1.5 micrograms per kilograms (μg/kg) ($\mu g/kg \approx \mu g/l$) (Shaw, 1980); analysis of the hydrocarbon compounds indicated they probably were biologically produced.

2) **Low-Molecular-Weight (LMW) Hydrocarbons**: The LMW hydrocarbons (hydrocarbon compounds with 1 to 4 carbon atoms [C_1-C_4] that include methane, ethane, and propane) in the water column of lower Cook Inlet were similar to their respective concentration in other Alaskan environments (Katz and Cline, 1981) (Table III.A.5-5). The concentrations of methane ranged from 55 to 3,072 nanoliters per liter (nl/l) (0.055-3.072 microliters per liter [μl/l]); concentrations of the other LMW hydrocarbons were <7 nl/l. The methane and other LMW hydrocarbons in lower Cook Inlet were derived from biosynthesis (Katz and Cline, 1981).

In upper Cook Inlet, the concentrations of methane ranged from 138 to 4,085 nl/l and were higher than those in lower Cook Inlet and other Alaskan waters. The highest methane concentrations were found in Trading Bay (Katz and Cline, 1981); producing oil fields are located in Trading Bay and gas fields, both producing and nonproducing, are located nearby. The characteristics of the LMW hydrocarbons in the waters of upper Cook Inlet suggest they are thermogenic in origin and could have entered the marine environment from submarine seeps or leakage from existing wells. The natural gas commercially produced in Cook Inlet principally consists of methane (>98%) and trace amounts of the higher hydrocarbons (Blasko, 1974, as reported in Katz and Cline, 1981). Methane concentrations decreased away from Trading Bay to levels similar to those found in lower Cook Inlet. Some of the general trends for ethane and propane were similar to those of methane.

3) **Volatile Organic Aromatic Compounds**: The concentrations of volatile organic aromatic compounds (benzene, ethylbenzene, toluene, xylenes, and dichlorobenzenes) in the water column at eight stations were less than the method-detection limit—1 μg/l (UAA, ENRI, 1995).

4) **High-Molecular-Weight (HMW) Hydrocarbons**: Neither saturated nor unsaturated HMW hydrocarbons (C_{14}-C_{35}) were detected in the filtered seawater and SPM fractions in the surface waters collected in the vicinity of the offshore oil-production platforms in upper Cook Inlet and on the east and west sides of Kalgin Island (Shaw, 1980).

Table III.A.5-5
Selected Summary of the Average and Range of Low-Molecular-Weight Aliphatic Hydrocarbon Concentrations Measured in Various Alaskan Marine Environments
(Concentration are in nanoliters per liter)

	Methane			Ethane			Ethene			Propane			Propene		
		Range			Range			Range			Range			Range	
Region	Avg	From	To	Avg	From	To	Avg	From	To	Avg	From	To	Avg	From	To
Beaufort Sea	210	15	1,151	0.8	0.4	1.6	1.2	1.2	15	0.3	T	0.9	1.0	0.1	8.7
Chukchi Sea	243	87	2,851	0.8	0.1	3.1	1.8	0.6	5.9	0.4	0.1	2.3	0.4	T	0.8
Bering Sea	217	48	2,222	0.9	0.1	8.3	2.3	0.2	6.4	0.4	T	2.9	0.8	T	9.5
Gulf of Alaska	212	12	2,075	0.4	0.1	13	0.9	0.1	3.4	0.2	T	5.9	0.4	T	1.7
Cook Inlet															
Upper	375 (±395)	55	3,072	0.6	T	4.2	1.7	T	6.9	0.3	T	2.0	0.6	T	2.4
Lower	1,089 (±900)	138	4,085	4.1	0.2	21	0.4	0.1	1.7	2.1	T	11	0.1	T	0.7

Source: After Katz and Cline, 1981.
Note: "T" indicates that values are <0.1 nanoliters per liter.

Table III.A.5-6
Summary of Metal Concentrations in Mussel Tissues
(μg/g dry weight)

	Location					
Metal	Tuxedni Bay	Fossil Point	Chinitna Bay	Jakolof Bay	Kasitsna Bay	Homer
Aluminum	1,380	456	2,030	101	78	254
Antimony	0.01	0.02	0.01	0.06	0.03	<0.0002
Arsenic	0.33	0.54	0.57	0.59	0.50	0.50
Barium	55.2	29.1	215.0	3.0	26.5	15.3
Berylium	0.1	<0.009	0.2	<0.009	<0.009	<0.009
Cadmium	4.47	4.98	6.67	4.13	2.62	1.76
Chromium	15.5	19.3	192.0	9.3	13.3	14.6
Copper	11.0	11.4	22.9	7.7	10.8	11.4
Iron	841	298	1,440	42	59	182
Lead	12.8	48.7	68.6	29.7	48.3	70.4
Manganese	78.8	103.0	255.0	7.4	8.8	28.8
Mercury	0.13	0.14	0.11	0.11	0.14	0.09
Nickel	33.7	35.2	133.0	33.7	6.8	11.8
Silver	0.07	0.01	0.32	0.05	0.04	0.05
Titanium	0.04	0.02	0.09	<0.003	0.01	0.02
Vanadium	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Zinc	57.4	85.3	148.0	98.4	138.0	171.0

Source: ENRI, UAA, 1995.

The total concentrations of saturated hydrocarbons, n-alkanes C8 to C36, in water samples collected in 1993 ranged from less than the detection limit (0.01 μg/l) to 4.14 μg/l (UAA, ENRI, 1995).

Although the two samples of treated produced waters from the Trading Bay Treatment Facility (Sec. III.A.5.a(4)(a)) contained about 3,600 and 3,920 parts per billion (ppb) (≈3.6-3.92 μg/l) of resolved alkanes (saturated hydrocarbons between C8 and C40), no detectable amounts of saturated hydrocarbons (C8-C40), individual or total, were found in the water samples from November 1993 (Neff and Douglas, 1994). The concentrations of individual alkanes in the treated produced waters ranged from <5 ppb to about 270 ppb. The reporting limits for the individual alkanes was 0.2 ppb, and the total was 50 ppb.

5) **Polynuclear (Polycyclic) Aromatic Hydrocarbons:** In the CIRCAC pilot study (Sec. III.A.5.c(4)(a)), mussels (*Mytilus edulis*) were used to determine PAH bioavailability in the water column (Hyland et al., 1995); the mussels were suspended in the water column for a month in the Beluga River and Trading Bay areas. The PAH assemblages in the mussels were less diverse than they were for pre-exposure mussels. Prior to exposure, the mean PAH concentration of the mussels was 84 nanograms per gram (ng/g [nano-one billionth] or parts per billion). Following suspension in the water column for a month, the mean PAH concentration in the mussels from the (1) Beluga River site was 94 ng/g (the increase was due mainly to higher concentrations of alkyl naphthalenes), and (2) the Trading Bay site was 24 ng/g. The lack of chronically available hydrocarbons (except possibly some naphthalenes), at the exposure sites apparently provided an opportunity for these organisms to cleanse themselves of most of the PAH's while suspended in the water column.

Total PAH concentrations in the Cook Inlet waters sampled by UAA, ENRI (1995) were below the detection limit (0.01 μg/l).

The concentrations of total PAH's in the water samples collected near the outfall of the Trading Bay Treatment Facility (Sec. III.A.5.a(4)(a)) ranged from 0.029 to 0.889 ppb (Neff and Douglas, 1994); the concentration of most of the individual PAH's was below the 0.01-ppb-reporting limit. The concentrations of total PAH's in the treated produced-water samples were about 837 and 883 ppb. The most abundant PAH's in the produced-water samples were alkylnaphthalenes and alkylphenanthrenes.

Except for one sample, no BTEX compounds were detected in the water samples (Neff and Douglas, 1994); the detection limit for these hydrocarbons was approximately 1.0 ppb. The sample with 0.889 ppb of total PAH's also contained 5.6 ppb BTEX; this sample was collected 50 m south of the outfall, and the high values of aromatic hydrocarbons may have been caused by the presence of an oil microdrop or by contamination. A treated produced water sample contained 6,860 ppb BTEX.

The total amount of PAH's in the SPM from surface and bottom water samples collected at three sites 750 m north, east, and south the Trading Bay outfall were determined (Neff and Douglas, 1994). The total PAH concentrations in the SPM ranged from about 19 to 136 ppb; the SPM concentration in the samples ranged from 0.5 to 3 mg/l. Individual PAH's that were detected in the SPM samples generally were below the reporting limit of 10 ppb. The surface water sample from north of the outfall contained traces of PAH's that are common in pyrogenic PAH assemblages. The most abundant of the higher molecular weight PAH's was perylene. Perylene primarily is derived from biogenic sources but may be present in small amounts in pertogenic and pyrogenic PAH assemblages.

6) **Toxicity:** Waters from eight stations were collected for a 48-hour liquid-phase sperm-cell sublethal bioassay to determine fertilization rates of the sand dollar *D. excentricus*; four stations were located in both upper and lower Cook Inlet (UAA, ENRI, 1995). In the sublethal sperm-cell test, the mean fertilization rates of *D. excentricus* in the sampled waters from five stations were reduced by a statistically significant amount; four of the stations were located in upper Cook Inlet and one station in lower Cook Inlet south of Kalgin Island. The reduced fertilization rate for three of the stations was <6 percent compared to the control and should not be considered an indication of toxic waters. The reduced fertilization rate for the two northernmost stations was 15 percent lower than the control and could be an indication of toxic waters. The waters from the two northernmost stations had high concentrations of SPM that may have contributed to the toxicity.

With the exception of the station in Kamishak Bay, there were no statistically significant differences between the survival of *D. excentricus* larvae in samples waters and control waters in the acute 48-hour-developmental tests

(UAA, ENRI, 1995). Larvae exposed to waters from the Kamishak Bay site had a survival rate that was < 10 percent of the control.

(d) **Hydrocarbons in the Surficial Sediments and Benthic Biota**: Fossil-fuel hydrocarbons that enter the water column may be adsorbed by detritial particles, deposited in the sediments, or sorbed by benthic organisms. Thus, the sediments and benthic organisms also can be used to determine if petroleum hydrocarbons are or were present in the water column.

1) Surficial Sediments:

Total Organic Carbon: In the late 1970's, the total organic carbon (TOC) content of the subtidal sediments of Cook Inlet and the northern part of the Shelikof Strait ranged from 0.1 to 1.4 percent (Kaplan et al., 1980; Venkatesan and Kaplan, 1982). The low TOC content of the sediments in Cook Inlet and Shelikof Strait is characteristic of unpolluted, relatively coarse sediments.

The total hydrocarbons in the sediments collected for the CIRCAC pilot study ranged from 0.12 to 0.77 percent; concentrations >0.5 percent were found in the sediments from Kachemak Bay (Hyland et al., 1995)

The TOC in all but one of the sediments sampled in the UAA, ENRI (1995) study ranged from 0.05 to 1.57 percent—these values generally were within the range of TOC found in the sediments sampled in the late 1970's (Kaplan et al., 1980; Venkatesan and Kaplan, 1982). The TOC in the sediment from a station located off the southwest end of the Kenai Peninsula was 4.09 percent; this relatively high concentration probably represents a piece of wood or coal in the sample (UAA, ENRI, 1995).

The concentration of total petroleum hydrocarbons in three surface sediment samples from a depositional area 2 mi northeast of the Trading Bay Treatment Facility outfall (III.A.5.a(4)(a)) ranged from 8.97 to 13.76 ppm (Neff and Douglas, 1994). The total concentration of resolved saturated hydrocarbons ranged from 1.07 to 2.56 ppm. Only n-alkanes with 19 or more carbon atoms were present in concentrations >0.1 ppm; the most abundant alkanes were C_{25}, C_{27}, and C_{29} alkanes and probably were derived mainly from plant waxes.

High-Molecular-Weight Hydrocarbons: The HMW hydrocarbons (C_{15}-C_{35}) detected in the intertidal and subtidal surface sediments of CI/SS mainly consisted of mixtures of compounds produced by terrestrial plants and by marine plants, zooplankton, and bacteria (Kaplan et al., 1980; Venkatesan and Kaplan, 1982; Shaw, 1977 and 1981). Based on dry weight, the aliphatic hydrocarbons ranged from 0.43 to 28.81 μg/g, the aromatics 0.27 to 23.81 μg/g, and the total n-alkanes <0.01 to 3.66 μg/g (Kaplan et al., 1980). Odd-numbered hydrocarbon compounds generally were more abundant than the even-numbered hydrocarbons; ratios of odd-number C compounds to even-number C compounds >1.5 indicate hydrocarbons of biogenic origin (Kaplan et al., 1980; Shaw, 1977, 1981).

The HMW hydrocarbons found in the sediments (from 2 sites) north of Kalgin Island were derived from petroleum (Kaplan et al., 1980; Venkatesan and Kaplan, 1982). The source of the petroleum hydrocarbons in these sediments may be from petroleum-production facilities located north of the Forelands, spills or discharges associated with petroleum transportation, or localized seeps. However, the sediments east and west of Kalgin Island did not show evidence of any petroleum residue (Kaplan et al., 1980; Venkatesan and Kaplan, 1982). The HMW hydrocarbons from coal were found in the sediments off Bluff Point (Shaw, 1981). The coal in these sediments might have come from coal outcrops in the Anchor Point-Bluff Point area.

The mean total concentration of n-alkanes (n-C12 to n-C32) in the 1993 sediment samples ranged from 62 to 2,666 ng/g (0.062 to 2.666 μg/l) (UAA, ENRI, 1995). The n-alkanes with 21 to 29 C atoms dominated, especially C27 and C29. There also was a strong preference for compound with odd-numbered C atoms over compounds with even-numbered C atoms. These characteristics indicated the saturated hydrocarbons were of biogenic origin, derived mainly from terrestrial plants.

Polycyclic (Polynuclear) Aromatic Hydrocarbons (PAH's): The subtidal sediments also contained PAH's derived from the high temperature (400-800 °C [Hunt, 1979]), incomplete combustion of wood (forest fires), or fossil fuels. In the OCSEAP studies, the concentrations of the individual compounds in the sediments ranged from not detected or trace to 266.3 ng/g. Winds and rivers could transport these hydrocarbons into the area from combustion sites located nearby or far away (Kaplan et al., 1980; Venkatesan and Kaplan, 1982).

The total PAH concentrations in the sediments from the CIRCAC pilot study were ≤105 ng/g at all stations and <60 ng/g at most stations (Hyland et al., 1995). A few individual PAH concentrations from several of the sediment samples exceeded 10 ng/g, but most ranged near the detection limits of 1 to 5 ng/g. The PAH distribution in the sediments from two of the samples sites, one off the Beluga River and the other in Trading Bay, were similar to the PAH distribution in the produced-water outfall in Trading Bay. The PAH distribution in the other two samples from the Beluga River and Trading Bay sampling areas were similar to those in the samples from Kachemak Bay. The samples from Kachemak Bay contained greater perylene concentrations than did the other sediment samples. Perylene (1) is a naturally occurring PAH formed by the chemical transformation of certain biological precursors, possibly plant pigments, in sediment during early diagenesis (Wakeha et al., 1980, as reported in Hyland et al., 1995) and (2) occurs in crude oil in low concentrations. The concentrations of the PAH's in the sediment samples are within the range of concentrations observed in unpolluted coastal and offshore environments..

The total PAH concentrations in the sediments sampled in 1993 ranged from <2 to 958 ng/g (UAA, ENRI, 1995); these concentrations are similar to the concentrations found in past Cook Inlet studies. In only about one-fifth of the samples were the concentrations of PAH >10 ng/g; PAH's were not detected in about one-half of the samples collected. The phenanthrene series were dominant in many of the samples with detectable PAH's, and this indicates hydrocarbons of petrogenic origin. A sample from a station located in Kachemak Bay had higher total PAH concentrations and levels of naphthalene compounds than samples from other locations; the more volatile naphthalene compounds indicate relatively recent petroleum inputs, and this could be an indication of pollution from the Homer vicinity (UAA, ENRI, 1995).

The PAH concentrations in the sediments northeast of the Trading Bay outfall (Sec. III.A.5.a(4)(a)) ranged from 93.3 to 116.2 ppb (ng/g) (Neff and Douglas, 1994). The assemblage indicated the PAH's in these sediments were derived mainly from pyrogenic sources. Perylene, derived primarily from the diagenesis of biogenic matter, was the most abundant HMW hydrocarbon in the sediments. The BTEX compounds were not detected in the sediments.

Toxicity: As part of the CIRCAC pilot study, sediment toxicities were measured with the marine amphipod *Ampelisca abdita* and the benthic clam *Macoma* spp. The PAH distributions in the tissues of clams from the Kamishak Bay and Kachemak Bay sampling sites were different than the PAH distributions in the sediments and consisted mainly of biogenic PAH's.

The survivability, after 10 days, of amphipods in the sediments from the four sampling areas (off the mouth of the Beluga River and in Trading, Kamishak, and Kachemak Bays) ranged from 61 to about 87 percent; the survivability in control sediments was 91 percent. The mortality of the amphipods did not appear to be related to any of the sediment parameters (TOC, PAH, and grain size) measured in the study but may have been caused by the presence of natural or manmade substance or substances not analyzed in the study.

The results of the bioassays indicate some of the sediments and pore waters from 12 stations sampled may contain substances sublethally toxic to the test organisms, although the causes are unknown (Table III.A.5-6) (UAA, ENRI, 1995). Amphipod 10-day-static sublethal bioassays (survival of *R. abronius* larvae) were conducted on sediment samples from all 12 stations, Microtox® bioassays were conducted on sediments from 11 stations, and mean fertilization rates of *D. excentricus* eggs bioassays were conducted in the sampled sediment pore waters from 9 stations. All three bioassays were conducted on samples from 8 of the 12 stations, and two bioassays were conducted on samples from 4 stations.

The bioassays at three of the stations where all three bioassays were conducted did not indicate the presence of any substances in quantities great enough to be sublethally toxic to the test organisms (UAA, ENRI, 1995). Two of these stations were located in upper Cook Inlet (one in Trading Bay) and the other in lower Cook Inlet. However, the presence of sublethal levels of toxic substances may be indicated by two of the three tests that were conducted on samples from four stations. At three of these stations, both the Microtox® and fertilization rate bioassays indicated toxic substances may be present; these stations were located near the southern end of Kalgin Island, in Tuxedni Bay and near the central part of the inlet off Tuxedni Bay. Also, the Microtox® and amphipod survival bioassays of samples from a Kachemak Bay station indicated toxic substance may be present. Bioassays on a sample from Trading Bay indicated substances that may be toxic in the amphipod survival test may be present but absent, or not detected, in the fertilization bioassay.

The individual bioassays indicated substances toxic to the test species may be present in, (1) 2 of the 12 amphipod survival stations (1 station in Trading Bay and the other in Kachemak Bay), (2) 5 of the 11 Microtox® stations (4 of the stations along the western side of lower Cook Inlet and the Kachemak Bay station), and (3) 3 of the 9 fertilization-rate stations (located along the western side of Cook Inlet—3 of the Microtox® stations) (UAA, ENRI, 1995).

2) **Benthic Biota:** In the OCSEAP studies, hydrocarbons were determined in the benthic biota from specimens collected at various sites throughout lower Cook Inlet. The biota included brown, green, and red algae; angiosperms; limpets; bryozoan; clams; mussels; snails; and urchins (Shaw, 1979, 1980). Based on dry weight, the concentrations of saturated and unsaturated hydrocarbons in the benthic (1) plants ranged from 2.08 to 1,880 μg/g and 3.05 to 157 μg/g, respectively, and (2) animals from 0.55 to 1,550 μg/g and 1.24 to 591 μg/g, respectively.

Most of the organisms analyzed contained only those hydrocarbons produced by contemporary biological processes (Shaw, 1980). In most of the specimens, the unsaturated hydrocarbons were more abundant than the saturated. Odd-numbered C compounds generally were more abundant than the even-numbered C compounds. Animal species often contained an array of hydrocarbons similar to that of their algal food sources.

Several of the plant and animal specimens also contained an array of compounds that suggested some of the hydrocarbons were derived from either petroleum or coal. Specimens of rockweed, a brown algae (*Fucus distichus*), from within the boat harbor on the Homer Spit contained an array of HMW hydrocarbons derived from petroleum; the habitat from which the specimens came suggests contamination from fuel oil. A red algae species (*Constantinea subulifera*) from an area adjacent to Bluff Point contained an array of hydrocarbons characteristic of the detrital coal and intertidal muds of the Anchor Point/Homer area (Shaw, 1979); coal outcrops are found on Bluff Point.

The HMW hydrocarbon compounds found in the deposit-feeding clams, *Macoma balthica*, obtained from the mudflats east of the Homer Airport contained a suite of compounds similar to those found in terrigenous plants and in the coal from the Homer area (Shaw, 1979).

Specimens of *Mytilus edulis* obtained from the mudflats east of the Homer Airport contained an array of HMW hydrocarbons that indicates the presence of fuel oil, which may be the result of pollution from the nearby town and boat harbor (Shaw, 1979).

In 1993 mussels, *M. edulis* were collected from six locations in lower Cook Inlet and their tissues sampled for saturated hydrocarbons (n-alkanes C11 to C30), selected PAH's, and trace metals (UAA, ENRI, 1995). The total concentration of the saturated hydrocarbons ranged from 0 to 1,800 ng/g; individual n-alkanes concentrations ranged from <0 to 2,300 ng/g. The compounds with 21 to 29 carbon atoms dominated, which indicates hydrocarbons of biogenic origin. No saturated hydrocarbons were detected in the tissue of mussels from Chitina Bay and Fossil Point; the saturated hydrocarbons in the tissues of mussels from a station in Tuxedni Bay was 13,800 ng/g. Total concentration of selected PAH's ranged from 0 to 400 ng/g. No PAH's were detected in the tissues of mussels from Kasitsna Bay and Homer sites.

The concentrations of the trace metals in the mussel tissues are variable and comparable with those obtained in past studies in Cook Inlet, Gulf of Alaska, and the Beaufort Sea; no anomalous trends were evident (UAA, ENRI, 1995).

(e) **Biodegradation:** Hydrocarbon-oxidizing microflora were found throughout the waters of Cook Inlet, and their presence indicates biodegradation is a continuing process (Button, et al., 197_). In upper Cook Inlet, microflora concentrations range from 1,000 to 10,000 organisms per liter, and in lower Cook Inlet their concentration range from 100 to 10,000 organisms per liter in the northern part and 10 to 1,000 in the southern part; about 10 percent of the population is capable of oxidizing petroleum. The oil-oxidizing microorganisms appear to be more abundant closer to shore than in the central part of the inlet.

(5) **Metals in the Marine Environment:**

(a) **Suspended Particulate Matter:** The concentrations of metals associated with the SPM are discussed in Section III.A.5(3).

(b) **Surficial Sediments:** In the 1993 Cook Inlet study (UAA, ENRI, 1995), replicate sediment samples were taken at 15 of 16 stations and the mean metal concentration ranges in the sediments are shown in Table III.A.5-7. The mean concentration ranges in upper and lower Cook Inlet are quite similar. These concentrations also are quite similar to the mean concentrations of metals found in sediments throughout the world. For antimony, arsenic, mercury, and zinc, the concentrations generally are lower that the lowest concentration of contaminates that adversely affect some marine organisms, as indicated by the Effects Range Low (ER-L) values in Table III.A.5-7; ER-L values represent the lowest concentrations of contaminants that adversely affect some marine organisms.. The samples with mercury concentrations greater than the ER-L value of 0.13 μg/g were from stations in both upper and lower Cook Inlet.

(c) **Benthic Biota:** The concentrations of metals in mussel tissues from six Cook Inlet locations are shown in Table III.A.5-8. The highest concentrations of metals in the mussel tissues generally were found in the mussels from Chinitna Bay.

d. **Pollutants:** The principal sources of pollutants entering the marine environment include (1) discharges from municipal wastewater-treatment systems; (2) discharges from industrial activities that do not enter municipal wastewater systems (petroleum industry and seafood processing); (3) runoff from urban, agricultural, and mining areas; and (4) accidental spills or discharges of crude or refined petroleum and other substances.

Pollutants may be classified as chemical, physical, and biological (Krenkel, 1987). The chemical pollutants include organic and inorganic substances. The decomposition of organic substances uses oxygen and, if enough organics are present, the concentration of oxygen could be reduced to levels that would threaten or harm oxygen-using inhabitants of the water column. The measure of oxygen-depleting substances is the biochemical oxygen demand (BOD). Some of the organic substances, such as oil (crude or refined), can have a wide variety of sublethal and lethal effects on marine organisms; these effects can impair subsistence, recreational, or commercial uses of the marine biological resources. The discharge of soluble inorganic substances may change the pH or the concentration of trace metals in the water, and these changes may be toxic to some marine plants and animals.

Physical pollutants include suspended solids, foam, and radioactive substances. Suspended solids may inhibit photosynthesis, decrease benthic activity, and interfere with fish respiration. Foam results from surface active agents and may cause a reduction in the rate of oxygen-gas transfer from the atmosphere into the water. Radioactivity may come from natural sources, fallout, or waste discharges and can be dissolved in the water or incorporated into the biota.

Biological pollution may cause (1) waterborne diseases by adding viruses, protozoa, or bacteria to the receiving waters or (2) excessive biological growth—eutrophication—by increasing the concentration of nutrients, nitrogen and/or phosphorus, in the waters; eutrophication also occurs naturally. The presence of coliform bacteria in the water is considered an indication of fecal contamination.

(1) **Regulatory Control of Pollutants:** The principal method for controlling pollutant discharges is through Section 402 (33 U.S.C. § 1342) of the Federal Water Pollution Control Act (commonly referred to as the Clean Water Act [CWA]) of 1972, which establishes a National Pollution Discharge Elimination System (NPDES) (Laws, 1987). Under Section 402, the U.S. Environmental Protection Agency (USEPA) or authorized states can issue permits for pollutant discharges, or they can refuse to issue such permits if the discharge would create conditions that violate the water-quality standards developed under Section 303 (33 U.S.C. § 1313) of the CWA. The CWA, Section 403 (33 U.S.C. § 1343), states that no NPDES permit shall be issued for a discharge into marine waters except in compliance with established guidelines.

The guidelines require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment (40 CFR 125.122). Unreasonable degradation of the marine environment means (1) significant adverse changes in ecosystem diversity, productivity, and stability of the biological community within

Table III.A.5-7
Summary of Metal Concentrations in Cook Inlet Sediments
(μg/g)

Element	Cook Inlet			Global	Effects Range Low[1] (ER-L)	Effects Range Medium (ER-M)
		Lower				
	Upper	West Side	East Side			
Aluminum	27,000-67,467	44,333-63,733	39-867-61,567	72,000	---	---
Antimony	<MDL-0.104	0.018-0.083	<MDL-0.054	1.2	2.0	25.0
Arsenic	4.5-11.5	1.6-11.8	2.4-8.8	7.7	33.0	85.0
Iron	16,200-40,867	23,467-49,300	21,900-36,230	41,000	---	---
Mercury	0.062-0.098	0.049-0.194	0.037-0.209	0.19	0.15	1.3
Zinc	41.9-133.0	60.8-119.0	44.9-95.8	95	120.0	270.0

Source: ENRI, UAA, 1995.

[1] ER-L values represent the lowest concentrations of contaminants that adversely affect some marine organisms.

Table III.A.5-8
Summary of Cook Inlet Bioassays—1993

Station Locations	Sediment/Pore Water					
				Bioassays		
	Total PAH (ng/g)	Total Alkanes (ng/g)	TOC (%)	Amphipod Survival[1] (%)	Fertilization[2] (%)	Microtox[3] EC50
Upper Cook Inlet—West Side						
East of Tyonek	0	1,615	0.49	100	98.4	>2
Trading Bay (North)	0	240	0.12	96	99.8	>2
Trading Bay (South)	0	876	0.61	▨ 82	96.6	
Lower Cook Inlet—West Side						
Near West Foreland	0	62	0.05	99	99.8	>2
North of Kalgin Island	1	484	0.08	99		>2
West of Kalgin Island	2	854	0.37	91	▨ 27.6	▨ 1.32
West of Tuxedni Bay	0	457	0.58	92	▨ 41.4	▨ 1.60
Tuxedni Bay	2	856	0.17	99	▨ 51.0	▨ 1.25
Mouth of Chinitna Bay	6	1,613	0.58	94	100	▨ 1.91
Lower Cook Inlet—East Side						
West of Ninilchik	3	1,044	0.69	100		>2
West of Anchor Point	22	2,666	1.59	97		>2
Kachemak Bay (Outer)	100	1,369	1.43	▨ 78	98.8	▨ 0.86

Source; ENRI, UAA, 1995

▨ Indicates Possible Contamination.

[1] Amphipod 10-day static sublethal bioassay (*R. abronius)* in sediments. Survival rates differing by more than 20 percent from controls often are considered to be of concern.

[2] Mean fertilization rate of *D. excentricus* eggs in pore waters. Fertilization rates that are statistically different than controls could indicate toxic pore water.

[3] Microtox[3]. Values <2 percent can be considered to indicate possible contaminated sediment.

the area of discharge and surrounding biological communities; (2) threat to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms; or (3) loss of aesthetic, recreational, scientific, or economic values, which is unreasonable in relation to the benefit derived from the discharge.

(2) **Point Sources of Pollutants:** The principal point sources of pollutants in Cook Inlet are the discharges from municipalities, seafood processors, and the petroleum industry.

(a) **Municipalities:** There are 10 communities in the Cook Inlet area discharging treated municipal wastewaters into Cook Inlet or into waters connected to or flowing into the inlet (Table III.A.5-9). Wastewater entering the plants may contain a variety of organic and inorganic pollutants, metals, nutrients, sediments, and bacteria and viruses. The wastewaters of (1) Anchorage (Point Woronzof Wastewater Treatment Facility), English Bay, Port Graham, Seldovia, and Tyonek receive only primary treatment and (2) Eagle River, Girdwood, Homer, Kenai, and Palmer receive secondary treatment. The maximum permitted wastewater discharge for (1) Anchorage is 44 million gallons per day (gpd) and (2) the other communities is a range from 10 thousand to 1.6 million gpd.

For Anchorage, the monthly average of the daily discharge of BOD and total suspended solids (TSS) in the wastewater is not to exceed 44,060 pounds per day (lb/day) and 36,720 lb/day, respectively (Table III.A.5-9). For the other communities, the maximum permitted discharges for BOD and TSS are <325 lb/day and 488 lb/day, respectively (Table III.A.5-9). Based on daily maximum permitted discharges, the communities could release about 16.38 million pounds of BOD and 13.82 million pounds of suspended solids into Cook Inlet annually. The amount of hydrocarbons discharged with municipal wastewater, based on worldwide estimates, may be significant (NRC, 1985).

A summary of effluent-monitoring data for Anchorage Water and Wastewater Utility Point Woronzof Wastewater Treatment Facility is shown in Table III.A.5-10. For 1993, the effluent-discharge rate averaged 30 million gpd; the BOD averaged about 25,800 lb/day (4,700 tons/year); and the TSS averaged about 12,300 lb/day (2,240 tons/year). The discharged average amount of zinc was about 18 lb/day (about 3.24 tons/year) and mercury was about 0.10 lb/day (about 36.5 lb/year). Oil and grease discharges averaged bout 5,360 lb/day (about 980 tons/year). Oil and grease analysis measures the amount of substances soluble in trichlorotrifluoroethane and includes thousands of organic compounds with varying physical, chemical, and toxicological properties.

The other communities bordering Cook Inlet and Shelikof Strait use septic tanks or other individual systems to treat domestic and commercial wastewaters.

(b) **Seafood Processors:** The commercial-fishing industry in the CI/SS area harvests a variety of finfishes and shellfishes that include salmon (king, red, coho, pink, and chum), herring, halibut, crab, shrimp, and various other species (Table III.A.5-11). Most of the commercial harvesting of the fishery resources generally occurs between April and October.

The fisheries harvests are processed at various onshore and offshore facilities to produce a variety of products that include fresh, frozen, and canned meat and roe (eggs from herring and salmon). The capacities of the various processing facilities range from <1,000 lb to several thousand tons per day. The number of onshore and offshore processors operating in the area varies with the species being harvested and from year to year. Many of the onshore processors are located in the tidal estuaries of rivers or in bays or inlets. The location of the offshore processors depends on the resources and where they are being harvested.

Processing of the commercial-fish harvests generates wastes that usually are discharged into the waters adjacent to the onshore plant or into the waters in which the offshore processors are operating. Estimates of the amount of waste generated during processing depends on the type of resource being processed (Table III.A.5-11). Assuming all the salmon, herring, and crab caught in Cook Inlet are processed in facilities located onshore or offshore in the area and based on the landings of halibut in Homer and Kenai, the amount of seafood wastes generated during the "fishing season" from these fisheries might range from about 5.56 to 18.92 million pounds of organic matter (Table III.A.5-11).

Table III.A.5-9
Municipal Wastewater Discharges into Cook Inlet

				Permitted Discharge Rates			
				Wastewater		Biochemical Oxygen Demand (lb/day)[MAL]	Total Suspended Solids (lb/day)[MAL]
Municipality	Population	Treatment	Receiving Waters	(million gallons per day)	(thousand gallons per day)		
Anchorage	226,338	Primary[1]	Knik Arm	44		44,060	36,720
Eagle River[A]		Secondary[2]	Eagle River	1.6		325	488
English Bay[CDP]	158	Primary[3]	English Bay		10		
Girdwood[A]		Secondary[4]	Glacier Creek	0.85			
Homer	3,660	Secondary[5]	Kachemak Bay	0.62		155	155
Kenai	6,327	Secondary[6]	Cook Inlet	0.5		325	325
Palmer	2,866	Secondary[7]	Matanuska River	0.5		100	100
Port Graham[CDP]	166	Primary[8]	Port Graham		30		
Seldovia	316	Primary[9]	Seldovia Bay		14		
Tyonek[CDP]	154	Primary[10]	Cook Inlet		31		
Totals				48.87	85	44,965	37,838
Total (both million and thousand gpd wastewater discharges)				48.96			

Sources: USDOC, Bureau of Census, Compiled by Alaska Department of Labor, Research and Analysis, June 1991.

A	Eagle River and Girdwood populations are included in the Anchorage census.
CDP	Census-designated place.
MAL	Monthly average limitation.

Treatment, Receiving Waters, and Permitted Discharge Rates:

[1] EPA NPDES Permit AK0022551.

[2] EPA NPDES Permit AK0022543.

[3] Alaska Department of Environmental Conservation Permit.

[4] EPA NPDES Permit AK0047856.

[5] EPA NPDES Permit AK0021245.

[6] EPA NPDES Permit AK0021377.

[7] EPA NPDES Permit AK0022497.

[8] Alaska Department of Environmental Conservation Permit 8923-DB001.

[9] Alaska Department of Environmental Conservation Permit 8923-DB003.

[10] Alaska Department of Environmental Conservation Permit 8923-DB007.

Table III.A.5-10
Anchorage Water and Wastewater Utility
Point Woronzof Wastewater Treatment Facility
Effluent Monitoring Data
November 1992 through October 1993

Discharge or Substance	Average Concentration		Daily output		Yearly Output		Minimum and Maximum Concentrations 1986-1993	Maximum Allowable Effluent Concentrations[1]
	µg/l	mg/l	g	lb	lb	tons		
Effluent Discharge 30,000,000 gallons/day			(Range 1986 to 1993—23 to 37 million gallons/day)					
Metals							(µg/l)	(µg/l)
Arsenic	5		567.75	1.25	456.25	0.23	<1 - 13	12,700
Cadmium	6		681.30	1.50	547.50	0.27	<0.5 - 30	112
Copper	54		6,131.70	13.52	4,934.80	2.47	38 - 120	100
Lead	10		1,135.50	2.50	912.50	0.46	<1 - 50	625
Mercury	0.4		45.42	0.10	36.50	0.02	<0.2 - 0.7	0.625
Nickel	26		2,952.30	6.51	2,376.15	1.19	<1 - 60	177
Silver	8		908.40	2.00	730.00	0.37	0.9 - 98	57
Zinc	71		8,062.05	17.77	6,486.05	3.24	41 - 240	1,450
Chromium (total)	21		2,384.55	5.26	1,919.90	0.96	<1 - 120	450
Beryllium	0.1		11.36	0.03	10.95	0.01		275
Nonmetals							(mg/l)	Monthly Avg. Daily Avg. (mg/l)
Dissolved Oxygen		6.8	772,140.00	1,702.25	621,321.25	310.66	2.1 - 8.6	[2]
BOD		103	11,695,650.00	25,784.06	9,411,181.90	4,705.59	68 - 132	120 140
Total Suspended Solids Average		49	5,563,950.00	12,266.20	4,477,163.00	2,238.58	39 - 86	100 130
Oil and Grease Average		21.4	2,429,970.00	5,357.08	1,955,334.20	977.67	8.2 - 30.1	[2]

Source: Kinnetic Laboratories, Inc., 1994.

[1] Effluent water-quality criteira were determined by assuming a dilution of 25:1 at the Zone of Initial Dilution boundary. Pollutant concentrations in the effluent should not exceed these values.

[2] No requirements for these substances.

Table III.A.5-11
Fishery Harvests and Wastes in Cook Inlet

Resource	Year	Harvest Range (million lb/year)		Percent[1] Waste	Waste Range (million lb/year)	
		From	To		From	To
Salmon (all species)[2]	1980-90	5.08	11.07	27.5	1.38	3.03
Herring	1980-90	2.70	13.84	92	2.48	12.73
Crab (dungeness)[2]	1980-90	>0.1	2	45	0.04	0.9
Halibut[3]	1989-91	6.64	9.02	25	1.66	2.26
Totals		14.52	35.93		5.56	18.92

[1] Meehan et al., 1990. (Other crab species have been harvested in lesser amount than the dungeness,and there have been no king or tanner crab fishery in Cook Inlet since 1988 [Northern Economics, 1992].)

[2] Northern Economics, 1991.

[3] IPHC, 1993, 1991, and 1990; based on landings in Homer and Kenai.

(c) Petroleum Industry:

1) **Introduction:** The activities associated with petroleum exploitation that are most likely to affect water quality in the CI/SS sale area are (1) the permitted discharges from exploration-drilling units and production platforms and (2) petrochemical-plant operations. Through 1991, there were 14 oil-production platforms and 1 gas-production platform operating in upper Cook Inlet (Table III.A.5-12). In addition, there were three production-treatment facilities located onshore; produced waters from 10 of the oil-production platforms are treated at these facilities. (In 1992, 3 oil-production platforms and 1 production-treatment facility were shut down.) In 1990, the oil-production platforms produced about 9 MMbbl of oil and 48 MMbbl of produced water (State of Alaska, AOGCC, 1990).

2) **Exploration and Production Discharges:** Petroleum-production operations in upper Cook Inlet discharge a large volume of water and a variety of chemicals used to conduct the various operations associated with petroleum exploration and production.

The characteristics of the produced waters, as well as other discharges—except drilling muds and cuttings—described in this section are based on information obtained during the Cook Inlet Discharge Monitoring Study that, basically, was conducted between April 10, 1988, and April 10, 1989 (EBASCO Environmental, 1990a,b). The monitoring program was required by the general NPDES permit for oil and gas exploration, development, and production facilities in Cook Inlet/Gulf of Alaska—General Permit Number AKG28500 (USEPA, 1986).

Produced Waters: Produced waters constitute the largest source of naturally occurring and manmade substances discharged into the waters. These waters are part of the oil/gas/water mixture produced from the wells and contain a variety of substances dissolved from the geologic formation through which they migrated and in which they became trapped. Also, chemicals are added to the fluids that are part of various activities including waterflooding; well workover, completion, and treatment; and the oil/water separation process. These chemicals might include flocculants, oxygen scavengers, biocides, cleansers, and scale and corrosion inhibitors; during the Cook Inlet Discharge Monitoring Study (Envirosphere Company, 1987: EBASCO Environmental, 1990a,b) of production platforms in 1987 and 1988, the types of chemicals added during the various operations ranged from <1 to 110 gpd per platform. The discharge of produced waters is an issue of significant concern because of the types and amounts of naturally occurring substances they may carry and manmade substances that may be added.

Before discharging into the waters of Cook Inlet, the produced waters pass through separators to remove oil and gas from the waters. The treatment process removes suspended oil particles from the waters, but the effluent contains dissolved hydrocarbons or those held in colloidal suspension (Neff and Douglas, 1994). Relative to the crude oil, the treated produced waters are enriched in the more soluble LMW saturated and aromatic hydrocarbons. As specified in the NPDES permit, the maximum daily discharge limitation of oil and grease in the produced waters discharged into the inlet is 72 mg/l, and the monthly average is 48 mg/l.

Some of the characteristics of the produced waters that were discharged into Cook Inlet during the Cook Inlet Discharge Monitoring Study are shown and described in Table III.A.5-13. The amount of oil and grease, BOD, and zinc in the discharges associated with petroleum production in Cook Inlet is shown in Table III.A.5-14; this information is based on concentrations shown in Table III.A.5-13 and produced water discharge rates in Table III.A.5-12. The BOD averaged about 22,120 lb/day (about 4,040 tons/year). The discharges included about 1.9 lb of zinc per day (about 0.35 tons/year). The amount of oil and grease discharged is about 1,530 lb/day (about 280 tons/year); this is about 75 percent of the monthly average specified in the NPDES permit. (As noted in Sec. II.A.5.d(2)(a) and Table III.A.7-7, the Municipality of Anchorage Point Woronzof Wastewater Treatment Facility discharges about 27,840 lb of BOD, 18 lb of zinc, and 3,560 lb of oil and grease daily.) As shown in the Cook Inlet Discharge Monitoring Study (EBASCO Environmental, 1990a) for oil production, the produced waters discharged into Cook Inlet contain a variety of hydrocarbons that include benzene (2.280 to 30.200 mg/l), toluene (1.050- 15.800 mg/l), phenol (0.0005-3.6800 mg/l), naphthalene (0.0025-6.500 mg/l), fluorene (0.0050-0.118 mg/l), pyrene (0.005-1.240 mg/l), and chrysene (0.0050- 0.0500 mg/l).

During the Cook Inlet Discharge Monitoring Study, the toxicity of the produced waters was determined by using a standard 96-hour static acute toxicity test (96 hour LC_{50}) to the marine invertebrate *Mysidopsis bahia* (EBASCO Environmental, 1990a). The toxicities of the produced waters ranged from 0.27 to 82.47 percent of the effluent

Table III.A.5-12
Oil and Gas Production Facilities—Cook Inlet Region

Facility Name	Operator	Facility Type	Latitude/ Longitude	Distance to Shore (n.mi/st.mi)*	Water Depth (ft. MLLW)	No. of Oil-Service Wells	No. of Gas Wells	Oil Production (bpd)	Gas Production (1,000xCFD)	Muds & Cuttings (bbl/well)	Produced Water (bbl/day)		Produced Water Discharge Location
											Peak	Average	
Anna	Unocal	Production Platform	60°51'37"N1 51°18'46"W	2.2/2.5	77	20 oil, 8 injection	0	2,700	210	15,000	2,000	1,500	Platform
Baker	Unocal	Production Platform	60°49'45"N1 51°29'01"W	6.5/7.5	102	11 oil, 4 service	1	1,000	280	26,000	55	30	Platform
Bruce	Unocal	Production Platform	60°59'46"N1 50°17'52"W	1.3/1.5	62	11 oil, 8 injection	0	600	370	15,000	700	160	Platform
Dillon[1]	Unocal	Production Platform	60°44'08"N1 51°31'45"	3.2/3.7	92	10 oil, 3 service	0	400	150	27,000	3,000	2,650	Platform
NCIU Tyonek "A"	Phillips	Production Platform	61°04'36"N1 51°56'54"W	4.75/5.5	70	0	12	0	165,000	---	185	170	Platform
SWEPI "A"	Shell Western	Production Platform	60°47'45"N 151°29'44"W	5.1/5.9	100	16	1	3,100	1,000	---	2,700	1,700	E. Foreland Facility
SWEPI "C"	Shell Western	Production Platform	60°45'50"N1 51°30'08"W	3.8/4.4	70	15	0	3,000	1,000	11,600	2,400	1,400	E. Foreland Facility
Granite Point	Unocal	Production Platform	60°57'30"N1 51°19'53"W	3.1/3.6	75	11 oil, 6 water injection	0	2,600	1,900	26,500	1,000	300	Granite Pt. Facility
Spark[2]	Marathon	Production Platoform	60°55'42"N1 51°31'50"W	1.6/1.8	60	4, with 1 shut-in	0	300	---	--	5,000	3,900	Granite Pt. Facility
Spurr[3]	Marathon	Production Platform	60°55'10"N 151°33'26"W	1.4/1.6	65	5, with 1 shut-in	1 shut-in	300	---	--	500	200	Granite Pt. Facility
Grayling	Unocal	Production Platform	60°50'13"N1 51°36'47"W	3.1/3.6	135	24 oil, 10 service, 1 abandoned	2	6,800	9,200	20,000	39,000	37,000	Trading Bay Facility
Dolly Varden	Unocal	Production Platform	60°48'28"N1 51°37'58"W	3.5/4.0	110	24	1, with 1 shut-in	6,700	Platform use only	13,500	33,800	31,300	Trading Bay Facility
King Salmon	Unocal	Production Platform	60°51'54"N1 51°36'18"W	2.1/2.4	80 (MSL)	19	1	5,000	6,000	15,000	42,000	40,300	Trading Bay Facility
Monopod	Unocal	Production Platform	60°53'49"N1 51°34'44"W	1.3/1.5	62	29 oil, 2 service	0	2,800	2,500	5,800	6,800	4,800	Trading Bay Facility
Steelhead	Unocal	Production Platform	60°40'54"N1 51°36'08"W	3.8/4.4	183	3	11	2,000	165,000	13,500	1,000	800	Trading Bay Facility
Granite Point[3]	Unocal	Onshore Separation	60°01'14"N1 51°25'14"W	1.71/1.9**	45***	---	---	---	---	---	5,200	4,400	Spark Platform
Trading Bay	Unocal	Onshore Separation	60°49'05"N1 51°46'59"W	1.71/1.9**	35***	---	---	---	---	---	120,000	115,000	Outfall
East Foreland	Shell Western	Onshore Separation	60°44'09"N 151°21'13"W	0.13/0.15**	35***	---	---	---	---	---	5,100	3,100	Outfall

Source: AOGA, 1991.

* Distance from nearest shore measured from low water as shown on NOAA nautical charts (n. mi = nautical miles; st. mi = statute miles).

** Distance of discharge point from shore. Location of Trading Bay facility is at the Spark Platform.

*** Water depth at location of discharge outfall (MLLW = mean lower low water).

[1] Dillon Platform Shutdown June 1992 (Alaska Report, 1992d).

[2] Spark Platform Shutdown January 1992 (Alaska Report, 1992a; 1992c).

[3] Spurr Platform and Granite Point Production Facility Shutdown May 1992 (Alaska Report, 1992b).

Table III.A.5-13
Chemical Analyses and Toxicity Test of Produced Water Samples

Facility	Field D.O. (ppm)	Field pH	Lab pH	Oil & Grease Spec[1] (mg/l)	Oil & Grease Grav[2] (mg/l)	BOD (mg/l)	COD (mg/l)	Salinity (‰)	Ammonia (mg/l N)	TOC (mg/l)	96-hr LC50[3]	Zinc (mg/l)	Total Aromatic[4] Hydro-carbons (mg/l)	Total Naphtha-lenes[5] Hydro-carbons (mg/l)
Onshore Production Treatment Facilities														
Granite Point														
Mean	**1.0**	**6.5**	**7.4**	**147.0**	**36.2**	**413**	**1,071**	**33.74**	**11.28**	**238**	**13.50**	**0.038**	**12.226**	**2.177**
Minimum	0.0	6.3	7.1	52.0	24.8	340	865	31.40	9.60	224	5.81	0.025	10.028	0.357
Maximum	1.8	6.9	7.6	209.0	50.7	504	1,290	36.30	12.90	251	19.36	0.100	15.205	5.765
Trading Bay														
Mean	**3.6**	**6.7**	**6.8**	**46.0**	**36.0**	**518**	**963**	**25.83**	**5.14**	**255**	**17.99**	**0.038**	**8.428**	**2.003**
Minimum	0.1	6.5	6.5	28.0	3.2	315	731	25.10	0.82	126	9.43	0.025	6.593	0.312
Maximum	8.1	7.0	7.1	58.0	70.1	780	1,100	25.56	7.70	367	25.00	0.100	11.739	5.480
East Foreland														
Mean	**0.3**	**7.5**	**7.8**	**12.3**	**18.9**	**470**	**962**	**20.60**	**10.55**	**306**	**21.66**	**0.101**	**13.091**	**4.190**
Minimum	0.0	6.9	7.4	11.0	10.3	360	731	19.38	8.50	234	13.15	0.025	10.077	0.293
Maximum	0.8	8.5	7.9	14.0	41.4	630	1,240	21.59	13.00	393	30.88	0.170	24.044	15.525
Oil-Production Platforms														
Baker														
Mean	**1.1**	**7.5**	**8.0**	**52.7**	**34.0**	**435**	**800**	**9.76**	**4.98**	**208**	**23.98**	**0.416**	**21.213**	**1.443**
Minimum	0.6	7.0	7.8	25.2	7.7	120	400	7.76	0.05	10	8.84	0.025	8.197	0.173
Maximum	2.0	8.2	8.3	96.4	131.0	758	1,154	13.00	7.70	749	41.61	4.300	31.622	2.847
Bruce														
Mean	**1.7**	**6.7**	**7.3**	**73.3**	**52.6**	**1,480.8**	**2,995.8**	**13.80**	**13.68**	**1,154.8**	**0.90**	**3.688**	**41.287**	**4.108**
Minimum	1.4	6.1	7.1	67.0	28.5	1,170.0	2,950.0	13.50	10.90	967.0	0.27	0.430	22.130	0.764
Maximum	2.1	7.3	7.5	82.0	81.3	1,860.0	3,050.0	14.16	17.00	1,430.0	2.47	8.000	62.335	13.277
Gas-Production Platform														
Phillips "A"														
Mean	**2.0**	**7.3**	**7.5**	**1.3**	**3.8**	**105**	**438**	**4.97**	**2.09**	**172**	**63.69**	**0.031**	**0.704**	**0.609**
Minimum	1.6	6.8	7.4	0.7	1.2	58	200	0.40	1.70	86	47.56	0.025	0.358	0.078
Maximum	2.5	7.6	7.7	2.1	7.0	124	533	9.90	2.41	209	82.47	0.60	1.271	0.400

Source: Ebasco Environmental, 1990a.

[1] EPA Method 413.2 - infrared, spectrophotometric method was used.

[2] EPA Method 413.1 - gravimetric method was used.

[3] *Mysidopsis bahia* was the test organism. LC_{50}'s are in percent of effluent.

[4] Total aromatic hydrocarbons is the total of all parameters using EPA Methods 602, 603, and 610. These include all the mono-, di-, and polycyclic aromatic hydrocarbons.

[5] Total naphthalenes is the total of all the diaromatic hydrocarbons.

Table III.A.5-14
Estimates of Oil and Grease, BOD, and Zinc in Cook Inlet Petroleum-Production Discharges

Facility	Produced Water Discharge Rate[1] (bbl/day)	Oil and Grease (Gravimetric)						BOD[2]			Zinc[2]		
		Permit—Monthly Average			Monitoring Study[2]			Monitoring Study			Monitoring Study		
		Conc. (mg/l)	Daily (lb)	Year (lb)	Mean Conc. (mg/l)	Daily (lb)	Year (lb)	Mean Conc. (mg/l)	Daily (lb)	Year (lb)	Mean Conc. (mg/l)	Daily (lb)	Year (lb)
Onshore Production-Treatment Facilities													
Granite Point	4,400	48	74.01	27,012.5	36.2	55.81	20,371.9	413	642.24	234,418.8	0.038	0.06	21.4
Trading Bay	115,000	48	1,934.27	706,008.0	36.0	1,450.70	529,506.0	518	20,873.98	7,619,003.0	0.038	1.53	558.9
East Foreland	3,100	48	52.14	19,031.5	18.9	20.53	7,493.7	470	510.55	186,350.3	0.101	0.11	40.0
Oil Production Platforms													
Baker	30	48	0.50	184.2	34.0	0.36	130.5	435	4.57	1,669.1	0.416	0.00	1.6
Bruce	160	48	2.69	982.3	52.6	2.95	1,076.4	1,480.8	83.02	30,303.1	3.688	0.21	75.5
Gas Production Platform													
Phillips "A"	170	48	2.86	1,043.7	3.8	0.23	82.6	105	6.25	2,283.0	0.031	0.00	0.7
Totals	122,860		2,066.47	754,262.2		1,530.58	558,661.1		22,120.61	8,074,027.3		1.91	698.1

[1] Table III.A.5-9
[2] Table III.A.5-10

(EBASCO Environmental, 1990a); these concentrations equal 2,700 to 824,700 ppm. The classification of relative toxicity of chemicals to marine organisms proposed by the IMCO/FAO/UNESCO/ WHO, reported in Neff (1991), provides a system for assessing relative toxicities. Concentrations <1 mg/l (or ppm) are very toxic; 1 to 100 mg/l are toxic; 100 to 1,000 mg/l are moderately toxic, 1,000 to 10,000 mg/l are slightly toxic, and >10,000 mg/l are practically nontoxic. (Toxicity is the inverse of the LC_{50}; so as the LC_{50} value increases, the toxicity associated with the substance decreases. For example, a substance with an LC_{50} of 1,000,000 ppm is less toxic than a substance with an LC_{50} of 3,000 ppm.) The produced waters sampled in the monitoring study would range in toxicity from slightly toxic to practically nontoxic.

Drilling Muds and Cuttings: The general NPDES permit authorizes the discharge of only approved generic drilling muds and additives. Drilling muds consist of water and a variety of additives (Table III.A.5-15); 75 to 85 percent of the volume of most drilling muds currently used in Cook Inlet is water (Neff, 1991).

When released into the water column, the drilling muds and cuttings discharges tend to separate into upper and lower plumes (Menzie, 1982). The discharge of drilling muds at surface ensures dispersion and limits the duration and amount of exposure to organisms (NRC, 1983). Most of the solids in the discharge, >90 percent, descend rapidly to the seafloor in the lower plume. The seafloor area in which the discharged materials are deposited depends on the water depth, currents, and material particle size and density (NRC, 1983). In most OCS areas, the particles are deposited within 500 ft below the discharge site; however in Cook Inlet, which is considered to be a high-energy environment, the particles are deposited in an area that is >500 ft below the discharge site (NRC, 1983). The physical disturbance of the seafloor caused by the deposition of drilling discharges may be similar to that caused by storms, dredging, disposal of dredged material, or certain types of fishing activities (NRC, 1983). Small particles of drilling mud—several centimeters in diameter—also may settle to the seafloor immediately following a discharge but would disperse within a day.

The upper plume contains the solids and water-soluble components that separate from the material of the lower plume and are kept in suspension by turbulence. Dilution rates as high as 1,000,000:1 may occur for drilling solids within a distance to 200 m of a platform with surface currents of 30 to 35 cm/s (about 0.6-0.7 knots) (NRC, 1983).

Since 1962, there were about 546 wells drilled in Cook Inlet (Table III.A.5-13). One Continental Offshore Stratigraphic Test (COST) Well and 11 exploration wells were drilled in Federal waters and 75 exploration and 459 development and service wells were drilled in State waters—mainly in upper Cook Inlet (State of Alaska, AOGCC, 1994). From 1962 through 1970, 292 wells were drilled (62 exploration and 230 development and service) (State of Alaska, AOGCC, 1994). From 1971 through 1993, the number of wells drilled per year has ranged from 3 to 20; the average number drilled per year is about 11.

For the Cook Inlet Sale 149 area, MMS estimates the (1) average exploration well will use about 360 tons of dry mud and produce approximately 440 tons of rock cuttings and (2) average development or service well will use approximately 80 to 370 tons of dry mud and produce about 560 tons of cuttings. Table III.A.5-16 shows estimates of the amounts of drilling muds (137,060 tons) and cuttings (295,320 tons) discharged into Cook Inlet between 1962 and 1993. The yearly discharge based on drilling 11 wells per year is estimated to be about 4,070 tons of drilling muds and 6,160 tons of cuttings. The amount of suspended sediments is estimated to be 10 percent of the discharge, or 1,023 tons. Drilling muds and cuttings characteristics; i.e., composition and specialty additives, are summarized in Appendix J.

The amount of barite (barium sulphate—$BaSO_4$) in the drilling muds is estimated by MMS (1994) to be about 63 percent (Table III.A.5-12); barium makes up about 59 percent of barite. The amount of barium that might have been discharged into Cook Inlet between 1962 and 1993 is estimated to be about 50,945 tons. For a single well discharging 360 tons of drilling muds, the amount of barium discharged is estimated to be about 134 tons. The USEPA limits on the amount of mercury and cadmium in the barite is 1 mg mercury per kilogram of barite and 3 mg cadmium per kilogram of barite (dry weight); these limits are assumed to be the concentration of mercury and cadmium in the discharged drilling muds. The amount of mercury and cadmium discharge per well (based on 360 tons of muds/well) is estimated to be 0.27 lb and 0.80 lb, respectively. The concentrations of trace metals in the drilling muds discharged into Alaska waters is shown in Table 3 of Appendix J.

Table III.A.5-15
Drilling Muds and Cuttings—MMS Estimates

Weight Estimates of Drilling Muds and Cuttings Discharges			Composition of Discharged Mud	
Well Type	Drilling Mud Components (Dry Weight—Short Tons)	Cuttings Produced (Dry Weight—Short tons)	Component	Weight Percent
Development	80 to 370	560	Barite	63.0
Delineation	360	440	Clay	24.0
Exploration	360	440	Lignosulfonate[1]	2.0
			Lignite	1.5
			Sodium Hydroxide	1.5
			Other	8.0

Source: USDOI, MMS, Alaska OCS Region, 1994.

[1] Chrome or ferrochrome lignosulfonates are the primary source of chromium in drilling muds. Two of the drilling muds authorized by the General NPDES Permit (USEPA, 1986) allow up of 15 lb per barrel of chrome or ferrochrome lignosulfonates to be added to the drilling mud. For drilling in Federal and State waters of Alaska, the petroleum industry has voluntarily replaced chrome lignosulfonates with deflocculants that do not contain chromium (Neff, 1991).

Table III.A.5-16
Estimates of Drilling Muds and Cuttings Discharged into Cook Inlet

		Drilling Muds		Drilling Cuttings	
Well Type	Number of Wells	Amount of Muds Used per Well (tons)	Total Amount of Muds Used (tons)	Amount of Cuttings Produced per Well (tons)	Total Amount of Cuttings Produced (tons)
Exploration[1]	87	360	31,320	440	38,280
Development and Service (1966-1970)[2]	221	80	17,680	560	123,760
Development and Service[3]	238	370	88,060	560	133,280
Totals	546		137,060		295,320

Sources: MMS, 1994; State of Alaska, AOGCC, 1994.

[1] Includes COST Well.

[2] For the development and service wells drilled between 1966 and 1970, it was assumed the drilling muds were recycled, and the amount of mud used per well was 80 tons.

[3] For the developoment and service wells drilled before 1966 and after 1970, it was assumed the drilling muds were not recycled, and the amount of mud used per well was 370 tons.

The toxicity (96-hr LC_{50}) of the muds used to drill 39 production wells in Cook Inlet between August 1987 and February 1991 ranged from 1,955 to >1,000,000 ppm for a marine shrimp (AOGA, 1991; Neff, 1991). The percentages of the wells with toxicities (1) >100,000 ppm was 79 percent, (2) between 10,000 and 100,000 was 10 percent, and (3) between 1,000 and 10,000 was 10 percent; concentrations >10,000 are practically nontoxic and between 1,000 and 10,000 are slightly toxic. The toxicity of the COST well drilling-fluid discharges ranged from (1) 32,000 to 150,000 ppm for shrimp, (2) 0.3 to 2.9 percent (3,000-29,000 ppm) for pink salmon fry, (3) >70,000 to >200,000 ppm for amphipods, and (4) 10,000 to 125,000 ppm for mysids. Thus, most COST well drilling-fluid discharges were practically nontoxic for a variety of marine organisms.

__Other Discharges:__ The characteristics of some of the other permitted discharges associated with oil- and gas-production activities in State of Alaska waters of Cook Inlet are described in the Summary Reports of the Cook Inlet Monitoring Study (Envirosphere Company, 1987; 1988; 1989a; 1989b; 1989c; EBASCO Environmental, 1990a) and summarized in the Comprehensive Report (EBASCO Environmental, 1990b). As noted in these reports, seawater is the principal component of most of the discharges; in some cases it is the only constituent. Also, there is a wide range of concentrations of the various additives in the discharges; the rate of adding compounds to the discharge ranges from <1 to several hundred gallons per month, while the discharge rates of the various effluents might range from 0 (for intermittent discharges) to several tens of thousands of gallons per day, or more. The produced water-treatment additives include biocides, scale inhibitors, emulsion breakers, and corrosion inhibitors. The range of maximum concentrations and toxicities (96-hr LC_{50}) for the (1) biocides is about 5 to 640 mg/l and slightly to very toxic, respectively; (2) scale inhibitors is about 30 to 160 mg/l and practically nontoxic to moderately toxic, respectively; (3) emulsion breakers is about 10 mg/l and toxic, respectively; and (4) corrosion inhibitors is about 20 to 160 mg/l and toxic, respectively (Neff, 1991).

The characteristics of exploratory drilling discharges, other than drilling muds and cuttings, also are summarized in Appendix J.

(d) __Petrochemical Plants:__ The petroleum-processing plants located in Cook Inlet are shown in Table III.A.5-13; as noted in the table, the Chevron Refinery ceased operations in September 1991. The monthly average discharge limitation for (1) the Tesoro Refinery includes BOD at 204 lb/day, chemical oxygen demand at 1,320 lb/day, and TSS of 48.3 lb/day, and (2) Union Chemical includes ammonia as N (nitrogen) of 1,925 lb/day and organic nitrogen (as N) of 2,973 lb/day (Table III.A.5-17).

(e) __Summary of Point-Source Discharges:__ Estimates of the annual suspended solids discharged from the municipalities (4.48 million lb), refinery (0.06 million lb), and drilling muds and cuttings (2.05 million lb) are only a fraction of the suspended sediments (80,123 million lb) discharged by the Knik, Matanuska, and Susitna Rivers (Table III.A.5-18). Estimates of the annual discharge of BOD or organic wastes from municipalities (9.41 million lb), seafood processors (5.56-18.92 million lb) and produced waters (8.10 million lb) are all about the same order of magnitude (Table III.A.5-18). The amount of zinc in the municipal discharges (6,486 lb) and produced waters (698) is only a fraction of the zinc in the river discharge (196,300) (Table III.A.5-18). Depending on the number of wells drilled, the amount of barium (which is relatively nontoxic to marine organisms) in the drilling muds discharged into Cook Inlet may exceed the amount supplied by streams.

(3) __Nonpoint Sources of Pollutants:__ Nonpoint sources of water pollution are multiple, diffuse sources of pollution (USEPA, 1990). Primary nonpoint sources of pollution include runoff from urban areas and communities, farms, and mining areas.

For this analysis, oil pollution from commercial and recreational vessels is considered to be a nonpoint source of pollution because of the dispersed character of the sources. Between 1965 and 1980, there were a reported 269 nonpetroleum-industry oil spills; the reported amount of oil spilled for 206 of the spills was 22,746 bbl—no volume was reported for 63 spills (State of Alaska, AOGCC, 1981). (Nonpetroleum-industry spills included spills from fishing boats, vessels carrying refined products to communities, and other vessels.)

(4) __Oil Spills:__ Oil spills have occurred in CI/SS, and these spills and the risk of future spills are an issue of major concern. The reported amount of oil spilled in Cook Inlet waters from 1965 through 1975 was 20,636 bbl; between 1976 and the end of 1979 an additional 9,534 bbl were reported spilled (State of Alaska, AOGCC, 1981). There were either no spills or any record of spills prior to 1965. Only the oil spills through 1975 and from 1976 through 1979 are noted in this section because the collection of the water, sediment,

Table III.A.5-17
Selected Effluent Characteristics: Tesoro Refinery and Union Chemical

	Discharge Limitations	
Effluent Characteristics	Monthly Average (lb/day)	Maximum Daily (lb/day)
Tesoro Refinery		
Biochemical Oxygen Demand (5-day)	204.0	371.4
Chemcial Oxygen Demand	1,320.0	2,464.9
Total Suspended Solids	166.3	261.4
Oil and Gas	48.3	86.9
Ammonia as N	85.9	190.1
Union Chemical		
Ammonia as N	1,9251	3,786
Orgnaic Nitrogen (as N)	2,973	5,557
Oil and Gas	—	15

Sources: USEPA, 19__.

[1] EPA Permit No. AK-000084-1.
[2] EPA Permit No. AK-000050-7.

Table III.A.5-18
Estimates of Selected River and Point-Source Discharges into Cook Inlet for 1 Year

Discharge Source	Total Discharges (million gallons)	Suspended Sediments (million lb)	BOD or Organic Wastes (million lb)	Oil and Grease (million lb)	Settable Solids (million lb)	Zinc (lb)
Rivers (Total Table III.A.5-1)	18,520,000					
Knik, Matanuska, Susitna (Gold Creek)	14,484,000	80,123				
Susitna River (Gold Cr)	2,352,000					196,300[1]
(Minimum)	(1,320,400)					(110,200)
(Maximum)	(3,071,700)					(256,300)
Ninilchik River	285,500	7.43				
Municipalities						
Permitted Discharge Rates-MAL[2]	17,870	13.81	16.41			
Anchorage-Point Woronzof MAL[2]	16,060	13.40	16.08			
Anchorage-Point Worzonof-1993[3]	10,950	4.48	9.41	1.96		6,486
Seafood Processing[4]			5.56-18.92			
Produced Waters[5]	1,945		8.10	0.56		698
Drilling Muds and Cuttings (11 wells/yr)[6]		2.05			18.41	
Refinery[7]		0.06	0.07			

MAL = Monthly Average Limitation

[1] Section III.A.5.b
[2] Table III.A.5-9
[3] Table III.A.5-10
[4] Table III.A.5-11
[5] Table III.A.5-14
[6] Section III.A.5.d(2)(c)
[7] Table III.A.5-17

and biota samples analyzed for hydrocarbons (Sec. III.A.5.c(4)) basically was conducted from 1975 through 1979. Additional information on oil spills in CI/SS is given in Section IV.A.

e. Summary: The water quality of lower Cook Inlet generally is good. Cook Inlet is a relatively large tidal estuary with a sizable tidal range. The turbulence associated with tidal currents mainly and the winds results in the vertical mixing of the waters. A relatively large volume of waters and a large variety of naturally occurring inorganic, mainly, and organic substances are transported into Cook Inlet by the streams and rivers and by currents from the Gulf of Alaska; the amounts of the individual substances discharged into the inlet appears to be quite variable. Substances transported into Cook Inlet that remain in suspension or dissolved in the water column are dispersed by the current regime. Also there are a variety of manmade substances routinely discharged into Cook Inlet. The major discharges are from municipalities bordering Cook Inlet, the oil and gas industry, and seafood processors. The quantities of manmade substances discharged into Cook Inlet generally are less than discharged by the streams and rivers. For some of the manmade substances, the amounts discharged may be within the range associated with the natural variability of stream and river discharges. In addition to the routine discharges, there have been a number of accidental spills of a variety of substances, including crude oil and refined petroleum products. Hydrocarbons are found throughout the marine environment, but generally the concentrations are low and of biogenic origin—mainly derived from terrestrial plants. The low concentrations of hydrocarbons in Cook Inlet are similar to concentrations found in other unpolluted coastal areas. The amount of TOC in the sediments, where contaminants could accumulate, is low and indicates an environment that generally is uncontaminated.

6. Air Quality: The existing onshore air quality adjacent to the Sale 149 area is relatively pristine, with regulated air-pollutant concentrations that are far less than the maxima allowed by the National Ambient Air Quality Standards (national standards) and State air-quality statutes and regulations designed to protect human health. Under provisions of the Prevention of Significant Deterioration (PSD) Program of the Clean Air Act, existing air quality superior to the national standards, such as in the Sale 149 area, is protected by additional limitations on nitrogen dioxide, sulfur dioxide, and particulate matter. Areas in Alaska are currently designated as PSD Class I or II. The Class I air-quality designation is the most restrictive and applies to certain national parks, monuments, and wilderness areas. Tuxedni National Wildlife Refuge is designated as a National Wilderness Area and is the only Class I area adjacent to the Sale 149 area; the remaining area is designated Class II. The applicable State and Federal standards and PSD Class I and II increments are listed in Table III.A.6-1.

Emissions consist of widely scattered small sources, principally from residences, refuse disposal, and small-village diesel-electric generators. The USEPA (1978) prepared emissions inventories and ambient-air-quality estimates for areas in Alaska with relatively small populations. These estimates for areas were derived from general emission-factor relationships with the local economic base and demographic data and indicate compliance with existing air-quality requirements. Since 1978, the increase in emissions sources in the area has not been significant. However, there is little available air-monitoring information from the area with which to quantify ambient pollutant concentrations. Estimates of ambient-air quality by the State of Alaska for remote areas with no existing data often conclude that ambient concentrations are near or below the level of detection by monitoring equipment (State of Alaska, Dept. of Environmental Conservation [DEC], 1987).

Table III.A.6-1
Ambient-Air-Quality Standards Relevant to Cook Inlet Sale 149
(micrograms per cubic meter)

	Averaging Time[1]					
Criteria Pollutant	Annual	24 hr	8 hr	3 hr	1 hr	30 min
Carbon Monoxide	*	*	10,000	*	40,000	*
Ozone[5]	*	*	*	*	235[6]	*
Nitrogen Dioxide	100[7]	*	*	*	*	*
Class I[4]	2.5[7]	*	*	*	*	*
Class II[4]	25[7]	*	*	*	*	*
Inhalable Particulate Matter (PM10)[8]	50[9]	150[10]	*	*	*	*
Class I[4]	4[3]	8	*	*	*	*
Class II[4]	17[3]	30	*	*	*	*
Lead	1.5[11]	*	*	*	*	*
Sulfur Dioxide	80[7]	365	*	1,300	*	*
Class I[4]	2[7]	5	*	25	*	*
Class II[4]	20[7]	91	*	512	*	*
Reduced Sulfur Compounds[2, 12]	*	*	*	*	*	50
Ammonia	*	*	*	2,100[13]	*	*

Sources: State of Alaska, DEC, 1982; 80 18 AAC 50.010, 18 AAC 50.020; 40 CF R 52.21(43 *Federal Register* 26388); 40 CFR 50.6 (52 *Federal Register* 24663).

NOTE: An asterisk (*) indicates that no standard has been established.

[1] All averaging times not to be exceeded more than once each year, except that annual means may not be exceeded.

[2] State of Alaska air-quality standard (not national).

[3] Annual geometric mean.

[4] Class I and Class II standards refer to the PSD Program. The standards are the maximum increments in pollutants allowable above previously established baseline concentrations.

[5] The State ozone standard compares with national standards for photochemical oxidants, which are measured as ozone.

[6] The 1-hour standard for ozone is based on a statistical, rather than deterministic, allowance for an "expected exceedance" during a year.

[7] Annual arithmetic mean. Monitoring at the refinery in Kenai (State of Alaska, DEC, 1986; Tesoro Alaska Petroleum Company, 1988) shows NO_x concentrations of 6.1 $\mu g/m^3$ (well below the 100 μ/m^3 standard). Modeling to estimate ambient air quality shows that the Kenai area meets Class II standards and that Class I standards are met at Tuxedni.

[8] PM10 is the particulate matter <10 microns in aerodynamic diameter.

[9] Attained when the expected annual arithmetic mean concentration, as determined in accordance with 40 CFR 50, subpart K, is $\leq \mu g/m^3$.

[10] Attained when the expected number of days per calendar year with a 24-hour average concentration above 150 $\mu g/m^3$ (as determined in accordance with 40 CFR 50, subpart K).

[11] Calendar-quarter arithmetic mean.

[12] Measured as sulfur dioxide.

[13] State of Alaska ambient air quality standard.

B. **Biological Resources:**

1. **Lower Trophic-Level Organisms**:

Lower trophic-level communities can be categorized as planktonic (floating or drifting in the water column) or benthic (living on or in the sea bottom). Planktonic communities typically consist of both phytoplankton and zooplankton. Benthic floral and faunal communities in the lower Cook Inlet and Shelikof Strait area are found in both the intertidal and subtidal zones. The abundance and distribution of planktonic and benthic organisms depend on many factors associated with the physical environment (e.g., wind, currents, turbidity, temperature, nutrient availability, and light) and the biological environment (e.g., competition and predation).

a. **Planktonic Communities:**

(1) **Phytoplankton**: Detailed seasonal data (April through August) in Cook Inlet were presented by Lawrence and Chester (1979) and Chester and Lawrence (1981, as cited in Sambrotto and Lorenzen, 1987). The results of these studies indicate that lower Cook Inlet and the Kenai shelf are among the most productive high-latitude shelf areas in the world during summer months. Primary production in this area is estimated to be at least 300 g C/m^2 (grams of carbon per square meter). Significant reductions in the amount of phytoplankton occur in lower Cook Inlet when large numbers of oceanic grazers (zooplankton) are brought into the area by the ACC.

Upper Cook Inlet is strongly affected by sediment loading (Kinney, Groves, and Button, 1970, as cited in Sambrotto and Lorenzen, 1987) due to the silt-laden freshwater that enters upper Cook Inlet. The shading caused by this suspended material is believed responsible for the reduced utilization of surface nitrate during the spring and may also slow the successional sequence of the phytoplankton species found there (Sambrotto and Lorenzen, 1987). Phytoplankton species present in abundances >1,000 cells/liter in lower Cook Inlet are listed in Table 9-8 in Sambrotto and Lorenzen (1987). Figure 9-21 from that same document shows the general distribution of the more dominant phytoplankton groups in lower Cook Inlet from April through August 1976.

The waters of Shelikof Strait originate primarily from the ACC, which travels in a counterclockwise direction throughout the Gulf of Alaska and from those of lower Cook Inlet. The ACC and a small portion of the Alaska Current (located farther offshore) enter lower Cook Inlet at Kennedy Entrance, encounter lower Cook Inlet currents, and combine to flow southwest through Shelikof Strait. As they enter lower Cook Inlet, they create a summerlong upwelling condition (Muench, Mofjeld, and Charnell, 1978, as cited in Sambrotto and Lorenzen, 1987), resulting in a probable vertical mixing of nutrients in that area. Because these currents from lower Cook Inlet continue through similar habitats in Shelikof Strait, the species and nutrients in Shelikof Strait are likely to be similar to those found in lower Cook Inlet.

(2) **Zooplankton**: Due to the flow and mixing of the ACC and the Alaska Current/Alaskan Stream, coastal zooplankton communities throughout the Gulf of Alaska consist of similar species (see Table 10-2 in Cooney, 1987). This mixed assemblage of oceanic and neritic species (approximately 30) inhabits the entire Gulf of Alaska shelf and coastal zone, including lower Cook Inlet and Shelikof Strait. Of these species, the lower Cook Inlet area is numerically dominated by nine species (copepods are most numerous). During the spring and summer months, the small copepods *Pseudocalanus* spp., *Acartia longiremis*, and *Oithona similis* numerically dominate the zooplankton community in lower Cook Inlet (Damkaer, 1977, as cited in Cooney, 1987). Other dominant species in lower Cook Inlet and Shelikof Strait include *Neocalanus plumchrus, Calanus marshallae*, and *Metridia pacifica* (Cooney, 1987). Between April and August, the zooplankton community in Kachemak Bay and lower Cook Inlet also is composed of barnacle nauplii and crab zoea (Cooney, 1987).

Annual secondary production levels for shelf and inside-water areas, such as lower Cook Inlet and Shelikof Strait, are largely unknown. Consequently, annual production estimates for zooplankton communities in lower Cook Inlet and Shelikof Strait are based on various assumptions. For example, Cooney (1987) reasons that because annual primary production for inside waters ranges between 100 and 300 g C/m^2, annual zooplankton production in coastal waters probably is 10 to 20 percent of this, or 10 to 60 g C/m^2. Seasonal zooplankton standing-biomass estimates for lower Cook Inlet and zooplankton production rates for shelf areas such as lower Cook Inlet and Shelikof Strait are shown in Tables 10-3 and 10-8 of Cooney (1987).

Zooplankton are used as food for fish, shellfish, marine birds, and some marine mammals. Zooplankton communities feed on plankton, and their growth cycles respond to phytoplankton production. In lower Cook Inlet and Kachemak Bay, zooplankton populations vary seasonally, with biomass in the upper 25 m reaching lows of 1.8 to 10.5 g/m^2 in the early spring and highs of 267.8 to 542.2 g/m^2 in the late spring and summer months (Damkaer, 1977, as cited in Cooney, 1987). However, Cooney (1987) reports that these spring and summer biomass estimates may be high due to the inclusion of either phytoplankton or smaller zooplankton in the samples taken. Cooney estimates that seasonal highs for zooplankton biomass in lower Cook Inlet would be between 67 and 135.6 g/m^2.

b. Benthic Communities: The intertidal and shallow subtidal habitats of lower Cook Inlet and Shelikof Strait support both infaunal (living in the substrate) and epifaunal (living at or above the substrate) organisms, as well as floral communities. Subtidal benthic communities in lower Cook Inlet (south of Kalgin Island) also support infaunal and epifaunal organisms. Because the intertidal and subtidal habitat of Shelikof Strait is similar to that found in eastern lower Cook Inlet, and because most of the water from lower Cook Inlet flows through Shelikof Strait, it is likely that the lower trophic species composition of the Shelikof Strait area would be similar to that described for eastern lower Cook Inlet.

(1) Intertidal and Shallow Subtidal Communities: The intertidal and shallow subtidal communities in the lower Cook Inlet area were evaluated by Lees et al. (1986). In western lower Cook Inlet, these communities were found to be strongly influenced by the effects of seasonal ice and exhibited strong affinities to those of the Bering and Beaufort Seas. However, in eastern lower Cook Inlet (ice free), these communities were similar to those of southeastern Alaska, British Columbia, and Washington.

Floral communities in the lower rocky intertidal and shallow subtidal zones of southeastern lower Cook Inlet were dominated by brown algae (*Alaria* spp., *Agarum cribrosum, Lamininaria groenlandica*, and *Nereocystis luetkeana*), while the midintertidal zone was dominated by *Fucus*. The lower intertidal and shallow subtidal areas were dominated by kelps out to depths of about 20 m. Faunal communities in this zone were found to be diverse and well developed in areas directly exposed to strong tidal currents. Dominant faunal species included herbivores (e.g., sea urchins, chitons, and limpets), suspension feeders (mussels, clams, polychaetes, bryozoans, and sponges), and predators/scavengers (e.g., sea stars, snails, crabs, and fishes). Rocky intertidal faunal assemblages exhibited strong seasonal variation, whereas subtidal assemblages were more stable.

The rocky intertidal and shallow subtidal floral communities in southwestern lower Cook Inlet were dominated by the brown algae *Fucus* and ephemeral red algae (mainly *Rhodymenia* spp.). Kelps dominated the low intertidal areas out to about 3 m in depth but were absent below about 5 m. The movement of winter ice was suggested as a possible cause for the lack of seaweeds within the midtidal zone. Faunal organisms within the seaweed zone were considered impoverished, possibly due to the scouring action of winter ice. Fauna in this area were dominated by microherbivores (e.g., limpets, and littorines) and predator/ scavengers (e.g., hermit crabs). Below the seaweed zone, the fauna were more diverse. Dominant fauna included suspension feeders (e.g., barnacles, bryozoans, social ascidians, and polychaetes) and predator/scavengers (e.g., sea stars, snails, and crabs).

The upper layers of sand in the intertidal zone in the lower Cook Inlet and Shelikof Strait typically were dominated by polychaete worms (e.g., *Scolelepis, Paraonella, Eteone,* and *Nephtys*) and gammarid amphipods (*Eohaustorius* and *Paraphoxus*). However, their biomass was low, and the use of these organisms by birds and fish also was low. The deeper sands were dominated by razor clams (*Siliqua patula*), which comprise the greatest percentage of the biomass on sandy beaches in the lower Cook Inlet and Shelikof Strait (Kaiser, 1977). Muddy beaches were typically dominated by clams (e.g., *Mya* spp. and *Macoma balthica*) and an echiurid worm (*Echiurus*). Biomass was high at sites dominated by *Mya*, moderate at sites dominated by *M. balthica*, and low at sites dominated by *Echiurus*. Use of faunal resources on muddy beaches by birds and fish may be high in spring, when birds are migrating north and salmon smolts are outmigrating from streams. Several species of crab and other fish also feed on mudflat organisms during spring and summer months.

(2) Subtidal Communities:

(a) Infauna: This group of lower trophic organisms consists primarily of mollusks, polychaetes, and bryozoans. Subtidal infaunal organisms taken from samples in lower Cook Inlet included over 370 invertebrate taxa (Feder et al., 1981, as cited in Feder and Jewett, 1987). Abundance values at sampling stations ranged from 150 to 3,988 individuals per square meter and the biomass from 21 to 731 g/m^2. Group one (muddy-bottom substrates) was dominated by mollusks and polychaetes. Group two (sandy-bottom substrates) was dominated by mollusks (see Fig. 12-7 in Feder and Jewett, 1987). Dominant taxa are shown in Table 12-13 in Feder and Jewett, 1987).

In the Kachemak Bay area, Driskell and Lees (1977, as cited in Feder and Jewett, 1987) have identified five subtidal areas consisting of four substrate types (rock, sand, silt, and shell debris) and their respective infaunal assemblages. Their work revealed that the northern infaunal assemblage located in a shell-debris area accounted for over 80 percent of the total species (mostly mollusks and bryozoans) collected in Kachemak Bay. The southern shell-debris, rippled-sand, muddy-sand, and silt assemblages were dominated by mollusks and juvenile bivalves, mollusks and pinkneck clams, bivalve mollusks (*Axinopsida serricata, Nuculana fossa, Pandora grandis, Nucula tenuis, Psephidia lordi, Spisula polynyma*, and *Yoldia seminuda*), and polychaetes.

Subtidal infaunal organisms (particularly bivalve mollusks) are important trophic links for crabs, flatfishes, and other organisms that are common in lower Cook Inlet (Feder and Paul, 1980; Rice, 1980; and Feder et al., 1981, all as cited in Feder and Jewett, 1987). Bivalve mollusks are abundant (76 species) throughout Cook Inlet (Driskell and Lees, 1977; Feder 1978; and Feder and Paul, 1980, all as cited in Feder and Jewett, 1987). The most common bivalves include *Nucula tenuis, Nuculana fossa, Macoma calcarea, Glycymeris subobsoleta, Spisula polynyma*, and *Tellina nuculoides* (Feder et al., 1981, as cited in Feder and Jewett, 1987). Deposit-feeding species dominate the fine sediments of the western Inlet, while suspension-feeding species are more common in the sandier areas of outer Kachemak Bay. Infaunal production values for lower Cook Inlet are estimated to range from 6.6 g/m^2 for Group 1 (muddy-bottom habitat—see Fig. 12-7 in Feder and Jewett, 1987) to 3.4 g/m^2 for Group 2 (sandy-bottom habitat). Production in outer Kachemak Bay, beneath the gyre outside of Kachemak Bay, south of Augustine Island in Kamishak Bay, and in Stevenson Entrance was estimated at 2.5, 6.3, 9.9, and 10.1 g/m^2 per year, respectively (Feder et al., 1981; Feder and Paul, 1981).

(b) Epifauna: This group of organisms consists primarily of shellfish (crustaceans). Rocky-bottom subtidal assemblages examined to date fall into three geographically distinct groups. The southern Kachemak Bay group consists of lush kelp beds (e.g., *Nereocystis leutkeana* and *Agarum cribrosum*) with low epifaunal diversity. The northern Kachemak Bay group consists of moderate kelp beds (similar to southern species) with well-developed components of sedentary and predator/scavenger invertebrates. The western Cook Inlet group consists of little or no kelp beds with a well-developed sedentary invertebrate component and a moderately developed predator/scavenger component. These groups are distinguished from one another on the basis of the composition and structure of macrophytes and epifaunal organisms. The dominant species associated with each group are listed on Table 12-15 in Feder and Jewett (1987).

From 1976 to 1978, trawl surveys conducted in the finer grained sediments of lower Cook Inlet yielded at least 287 invertebrate species (Feder and Paul, 1981, as cited in Feder and Jewett, 1987). The dominant phyla, in numbers per square meters, were anthropods (Crustacea) (191%), mollusks (35%), and echinoderms (3%). In terms of live weight, the species includes tanner crab (38.6%), humpy shrimp (*Pandalus goniuris*) (20.7%), red king crab (7.2%), and sea cucumber (*Cucumaria fallax*) (4.8%). In inner Kachemak Bay, omnivorous pandalid shrimp (pink—*P. borealis*, humpy, and coonstripe—*P. hypsinotus*) dominated. Outer Kachemak Bay was dominated by the green sea urchin (*Strongylocentrotus droebachiensis*), sea cucumber (*C. fallax*), and the sand dollar (*Echinarachnius parma*). In Kamishak Bay, crangonid shrimps were found to be most numerous, with tanner crabs dominating the total biomass for the area. The central portion of lower Cook Inlet was dominated by tanner crabs and sand dollars, whereas the outer portion of the Inlet was dominated by tanner and king crabs. Presumably due to high rates of primary production and nutrient mixing (Lawrance and Chester, 1979, as cited in Feder and Jewett, 1987), outer Kachemak Bay supported the greatest epifaunal biomass overall.

Tanner crabs were found to be present throughout all regions of lower Cook Inlet. Juvenile tanner crabs were concentrated in the western and southwestern Inlet and were found to be the primary prey of Pacific halibut (*Hippoglossus stenolepsis*), Pacific cod (*Gadus macrocephalus*), and great sculpin (*Myoxocephalus polyacanthocephalus*). Tanner crabs have been observed to feed on small clams, hermit crabs, barnacles, and crangonid shrimps (Paul, Feder, and Jewett, 1979, as cited in Feder and Jewett, 1987). Historically, the Kamishak Bay and Barren Islands areas have produced most of the commercially caught tanner crabs in lower Cook Inlet. Dungeness crabs accounted for only 1.2 percent of the epifaunal biomass during the 1976 and 1978 trawl studies and were generally confined to the Kachemak Bay area.

King crabs occurred year-round in Kachemak and Kamishak Bays, and most (95%) were sexually mature. The rocky shallow outer portions of Kachemak Bay give evidence of being a nursery area for king crab (Sundberg and Clausen, 1987, as cited in Feder and Jewett, 1987). Adult king crabs in the Kachemak Bay area were found to predominately feed on the pinkneck clam (*Spisula polynyma*), barnacles, and the snail (*Neptunea lyrata*). The food of postlarvel individuals (3- to 5-millimeter- [mm-] carapace length) from northwest Kachemak Bay consisted of crustaceans (45%), polychaete worms (31%), foraminiferans (27%), and the bryozoan *Flustrella* sp. (10%). King crabs in the Kamishak Bay area were found to predominately feed on barnacles (81%), bivalves (13%), and hermit crabs (12%). King crabs sampled in the Augustine Island area also were found to feed heavily on barnacles.

The southern portion of lower Cook Inlet (including Kachemak Bay) also supports the three numerically important species of pandalid shrimp already mentioned (*P. borealis, P. hypsinotus*, and *P. goniurus*). These species were observed to feed predominately on diatoms, polychaetes, bivalves, and crustaceans. Crangonid shrimps also were abundant in this area with *Crangon dalli* the dominant species taken (Feder and Paul, 1981, as cited in Feder and Jewett, 1987). These shrimps were observed to feed mostly on polychaetes, crustaceans, and bivalve mollusks. They in turn are fed upon by tanner crabs (Paul, Feder, and Jewett, 1979) and bottom-feeding fishes (Feder et al., 1981).

2. Fisheries Resources:

a. Introduction: This section discusses representative species of finfishes found in the lower Cook Inlet region. The descriptions emphasize those aspects of the morphology and life history of these species that the proposed action may influence. To facilitate comparisons and reference, the discussed species are arranged in phylogenetic (degree of complexity) order. Additionally, most of the species selected for discussion and effect analysis have subsistence-, commercial-, and sport-fishing values.

b. Species Discussions:

(1) Pelagic Fishes: These finfish species usually inhabit the upper layers—above the abyssal (deepwaters, generally below 1,000 m) zone—of the ocean water column and beyond the littoral (nearshore zone between high- and low-water marks) zone. Many of the finfishes in this grouping migrate long distances in response to changing environmental conditions for food or reproduction.

(a) Pacific Herring (*Clupea harengus pallasi*): This comparatively small, primitive, and indistinctive fish occurs in large schools in the lower Cook Inlet region in early April and possibly through early fall. Herring enter the region to spawn in the littoral zone; after spawning, the adults and resulting progeny may remain within the area until the onset of colder winter water temperatures. Pacific herring of the lower Cook Inlet region well may migrate to the deeper and slightly warmer waters of the Gulf of Alaska to overwinter.

Herring spawn in the spring, depositing their adhesive eggs on rocky substrate kelp and other vegetation of the littoral zone. These eggs are fertilized by extensive concentrations of milt that may cloud the water along many miles of coastline during the spawning season. In the lower Cook Inlet region, herring usually first spawn in their second year and may continue to spawn annually for up to 15 years. The number of eggs per female may range as high as 134,000; however, 20,000 per female is a more realistic number. These eggs hatch in about 3 to 7 weeks (depending on water temperature), and the resultant early pelagic larvae, of limited mobility, may remain in nearshore waters for some time (State of Alaska, Dept. of Fish and Game [ADF&G], 1991).

Herring spawn extensively along much of the Shelikof coastline of Kodiak Island and South Alaska Peninsula, areas that might be affected by the proposed action. Kamishak Bay is one major spawning area that supports a short-season sac-roe fishery. At this time, there is no roe-on-kelp fishery in the project area. Currently, the lower Cook Inlet region herring populations are increasing (State of Alaska, ADF&G, 1991).

(b) Eulachon/Candlefish/Hooligan (*Thaleichthys pacificus*): This small (to about 23 cm in length) forage fish is found throughout much of the proposed sale area. Anadromous eulachon move nearshore in early May and spawn in drainages throughout Cook Inlet. Depending on size, egg complements range from 17,300 to 39,600 fish, with an average of about 25,000 eggs. The eggs are deposited on stream gravels, and they hatch in about 30 to 40 days (depending on water temperature). The larvae then move downstream to enter marine waters (Hart, 1973).

Currently, there are no biomass estimates for this species in the proposed sale area, although populations are largely unexploited. There are small-scale gillnet fisheries on some Kenai Peninsula streams and dipnet-net fisheries in upper Cook Inlet. Eulachon also are important food for other fishes, birds, and marine mammals.

(c) <u>Capelin (*Mallotus villosus* [Muller])</u>: This species is a major forage fish of the lower Cook Inlet region. A small (mature specimens generally are 13-20 cm [5-8"] in length) but salmonlike fish, capelin are classified within the family *Osmeridae* (along with smelts). The populations of capelin are large, and they range extensively over Alaskan waters generally inhabiting the pelagic zone. Capelin mainly are filter feeders, thriving on planktonic organisms such as euphausiids and copepods.

Capelin spawn on beaches and in deeper waters and are highly specific regarding spawning conditions. Temperature, tide, and light conditions are important criteria for successful spawning; most spawning takes place at night or in dull, cloudy weather. On the Pacific coast of Canada, capelin spawn on gravelly beaches in various localities in the Strait of Georgia during late September or October. Capelin also have been observed spawning in the southwestern Bering Sea in May (personal observation), and spawning capelin have been harvested from Bristol Bay at about the same time. Capelin eggs are demersal, attached to beach and bottom gravels. Depending on temperature, hatching ranges from 15 to 55 days. Most capelin die after spawning. At present, capelin have no economic value to Alaska; however, the species is an extremely important food for other fishes, marine mammals, and seabirds.

(d) <u>Salmonids</u>: The lower Cook Inlet region is a significant migratory and early rearing area for all five species of Pacific salmon and for steelhead trout. These anadromous fishes transit much of the area, including Shelikof Strait, as smolt leaving natal (home) freshwater drainages and again as returning adult spawners. Juvenile salmonids from Prince William Sound following ocean currents also probably transit much of Shelikof Strait and also may enter Cook Inlet. Salmon in this region afford a high value to the commercial-fishing industry. In 1991, the regional catch totaled about 13.4 million of all species; this number does not include the sport-fish catch of salmon and steelhead trout, which is much smaller but still significant in economic value (State of Alaska, ADF&G, 1991). Under present management research and enhancement programs, no large-scale declines in the lower Cook Inlet region salmonid populations are expected to occur.

<u>Pink Salmon (*Oncorhynchus gorbuscha*)</u>: Pink salmon, at maturity, are the smallest of the five species of Pacific salmon, averaging about 1.4 to 2.3 kg (3-5 lb), and to 76 cm (30 in) in length. Spawning pink salmon reach the lower Cook Inlet region in early July annually, where they spawn in most streams of this region. Additionally, pink salmon may spawn in the intertidal zone in some streams. Each female has an average egg complement of about 1,500 to 1,900, and the eggs hatch in late February. The yolk-sac fry remain in stream gravels until early spring, at which time they migrate to the ocean. Pink salmon rear in the North Pacific Ocean for two winters before returning to the lower Cook Inlet region to spawn and die. Pink salmon are seasonally distributed over most of this region from spring through early fall annually.

Additionally, pink salmon exhibit cyclical population variance with runs to Kodiak, the South Alaska Peninsula, and Cook Inlet, with larger numbers occurring during the even-number years. In 1992, the most recent data year, the pink salmon harvest in the lower Cook Inlet and Shelikof Strait region totaled 3,222,691 fish (State of Alaska, 1992).

<u>Chum Salmon (*O. keta*)</u>: Chum (dog) salmon range over much of the proposed sale area. This species ranges to 100 cm (40") in length (McPhail and Lindsey, 1970) and 1 to 6 kg (6.6-13.2 lb) in weight (Rogers, 1992). Food consists of a variety of macroscopic organisms that inhabit the pelagic marine waters where this species migrates. Chum salmon enter the lower Cook Inlet region beginning in early July, and the spawning runs continue through early August. Chum salmon spawn in many streams throughout the region; with the eggs deposited in stream gravels. Egg complement is 2,000 to 4,300, and the eggs hatch in early spring. Chum salmon fry then move downstream to the ocean where they remain for three to four winters before returning to their natal streams to spawn and die. During 1992, chum salmon catch in the sale area totaled 578,751 fish. There are no biomass estimates for this species; however, the population is thought to be stable.

Coho Salmon (*O. kisutch*): The last of the Pacific salmon to return to the sale area to spawn, coho salmon enter the region in late July, and the runs continue until September. Coho salmon range to 96 cm (38 in) in length and average about 2.7 to 5.4 kg (6-12 lb) in weight (McPhail and Lindsey, 1970). The eggs (ranging from 2,500-5,000 per fish) are deposited in stream gravels, and the resultant fry remain in the stream for two winters before migrating to the ocean. In the sale area, this migration usually occurs annually from March through June. Coho remain in the North Pacific Ocean for two to three winters before returning to spawn in their natal stream. Coho harvest in the sale area for 1992 totaled 215,180. There are no biomass estimates for this species.

Rainbow Trout (*O. mykiss*)/*Salmon*): Formerly classified with the genus *Salmo* (trouts), the rainbow trout (steelhead) is now assigned to the genus *Oncorhynchus* because it is more closely related to others in this genus. The anadromous sea-run race of this species, the steelhead, is unevenly distributed throughout the lower Cook Inlet region. Information on the steelhead in Alaska tends to be limited to those few areas where larger populations support well-known sport fisheries. The Kenai and Anchor Rivers and Deep Creek on the Kenai Peninsula support fishable runs.

Steelheads enter freshwater over a considerable period of time, from early fall into the winter months. Spawning occurs in the spring, with larger females having egg complements of as many as 7,600 eggs. Steelheads probably enter the ocean after a year in freshwater streams. While small numbers may be taken incidental to the commercial-salmon catch and in the commercial ocean-trawl fisheries, most of the harvest is by sport fishermen.

Sockeye Salmon (*O. nerka*): The sockeye (red) salmon probably is the most important commercial-salmon species in the lower Cook Inlet region, with extensive runs to streams and lakes on the south Alaska Peninsula, Kodiak Island, and lower Cook Inlet. Sockeye salmon range to 84 cm (33") in length and to about 7 kg (15.5 lb) in weight (McPhail and Lindsey, 1970). These fish migrate in large schools over much of the North Pacific Ocean and into the eastern Bering Sea. Adult sockeye spawners return to the lower Cook Inlet and Shelikof Strait region in late June annually, and the runs continue through early August. On Kodiak Island, the Karluk and Fraser rivers are important sockeye salmon systems. Sockeye salmon also are notable in that their spawning areas usually require access to a lake or lakes, because the fry spend one to two winters in these areas before their seaward migration. Sockeye salmon usually spend two or three winters in the North Pacific Ocean before returning to spawn and die. In the ocean, sockeye salmon consume a variety of macroscopic fauna from the pelagic zone. It appears that some sockeye salmon runs in the sale area are in short-term decline for unknown reasons. The 1992 harvest in lower Cook Inlet and Shelikof Strait region totaled about 3,697,195 sockeye.

Chinook (King) Salmon (*O. tshawytscha*): The largest of the Pacific salmon species at maturity, chinook salmon range to 57 kg (126 lb) in weight and 147 cm (58 in) in length (McPhail and Lindsey, 1970). In the sale area, chinook salmon are distributed widely with large runs to the Kenai, Anchor, Ninilchik, and several other rivers of this region. Their ocean habitat is in the pelagic zone where chinooks migrate over large areas of the North Pacific as they rear to maturity. Chinook salmon prey on other finfishes of this zone—herring, capelin, eulachon, and similarly sized fish species. Smaller chinook salmon consume a variety of macroscopic fauna found in pelagic waters, e.g., amphipods, euphausiids.

Spawning chinook salmon enter the sale area during early May and are present in some spawning streams by the end of that month. During this same period, chinook salmon smolt are migrating downstream to enter the North Pacific Ocean.

Chinook salmon spawn in late June through late July in most areas. Egg complements may be as high as 8,000; however, 4,000 to 5,000 are more common. The eggs are deposited in stream gravels, where they incubate for several months. Chinook salmon rear in freshwater for two winters before their seaward migration, and they may spend 3 to 4 years in the ocean. In 1992, the chinook salmon harvest totaled 23,592 in the sale area. There are no biomass estimates for this salmon.

(2) **Groundfish:** This term loosely groups the large number of finfishes that, for much of their time, remain near the seafloor. Spawning and early life, however, may be in pelagic waters. The following groundfish species are considered commercially important in the lower Cook Inlet region.

(a) **Pacific Cod (*Gadus macrocephalus*):** This largely demersal (bottom-dwelling fish) may reach a size of 1 m (3.25 ft). Pacific cod are fast growing, maturing in 3 years. There is concurrently rapid turnover in the populations as predation and commercial fishing take their toll. Pacific cod spawn during an extended period, possibly February through July (USDOC, NOAA, OCSEAP, 1992). The adhesive, demersal eggs hatch in about 13 to 14 days (depending on temperature). The resultant larvae are pelagic for a time before entering the benthos. Pacific cod feed on pollock, herring, smelt, mollusks, crabs, shrimp, and other similar sized marine organisms (Hart, 1973).

The species is distributed over most of lower Cook Inlet and Shelikof Strait region, and 1,665,531 lb were harvested from the area during 1992 (State of Alaska, ADF&G, 1992, personal comm.). There is no biomass estimate for this species in this region.

(b) **Pacific Hake (Pacific Whiting) (*Merluccius productus*):** This codlike fish may be found throughout the lower Cook Inlet region, although not in large numbers. Ranging to about 91 cm (36 in) in length, its principal identifying characteristic is the presence of two dorsal fins. Hake spawn for an extended annual period, possibly for up to several months in this region. Depending on the size of the fish, hake may have nearly a half million eggs per individual, and the pelagic eggs may hatch in as little as 3 days. Hake are benthic in nature, although there are nocturnal movements to upper waters, probably for feeding. Larval hake consume copepods and similarly sized organisms. Adult hake prey on euphausiids, sand lance, anchovies, and other forage fishes. In turn, hake are important forage for other marine fishes, marine birds, and marine mammals. Formerly of low commercial value, improvements in processing technology will increase the commercial use of hake (Hart, 1973).

(c) **Walleye Pollock (*Theragra chalcogramma*):** This codlike species occurs throughout the proposed lease-sale area with a large spring spawning aggregation in parts of Shelikof Strait. Pollock are found at depths of 20 to 2,000 m. The species also is found near surface waters in some areas at some times. In size, walleye pollock range to 91 cm (36 in); however, they enter the commercial-trawl fisheries at about 25 cm (12 in) (Hood and Zimmerman, 1986). Adult pollock consume shrimp, sand lance, herring, small salmon, and other similar organisms that they encounter. The species also is cannibalistic.

Walleye pollock spawn in the spring in large aggregations, although there is extended spawning by smaller numbers throughout the year. The eggs may be close to the surface initially, and they hatch in about 10 to 20 days (depending on water temperatures). The pelagic larvae remain at the surface for periods of up to 30 days, again largely dependent on water temperature (and available food supply). At about a 25-mm length (Bakkala, 1975), the immature pollock move to deeper waters.

To date, the provisional biomass estimate for pollock for the lower Cook Inlet and Shelikof Strait region trawl and harvest sample surveys indicate a decline in walleye pollock population, which may be attributable to commercial fishing and/or changing environmental conditions.

(d) **Pacific Ocean Perch (*Sebastes alutus*):** This representative species of the 30 rockfish species so far recovered from the Gulf of Alaska ranges over much of the continental shelf of the Gulf of Alaska westward to the nations of the Russian Commonwealth. This group is unique in that many are very long lived and bear their young alive. The Pacific Ocean perch was formerly a much-sought-after commercial species that was then overexploited.

Adult Pacific Ocean perch usually are found in gravel, rocky, or boulder-strewn substrates in and along the gullies, submarine canyons, and depressions of the upper continental slope (Alverson and Westerheim, 1961). Larvae and juveniles are pelagic until joining the adults in these demersal habitats after 2 or 3 years (Alverson and Westerheim, 1961; Lyubimova, 1964).

(e) **Sablefish (Black Cod) (*Anoplopama fimbria*):** This cod ranges throughout much of the sale area and is a valued commercial species at this time. Sablefish largely are benthic in habitat with some nocturnal movement toward pelagic waters. The species usually occurs at depths of 200 to 500 fathoms (366-915 m). Sablefish range to 1 m (40 in) in length and are a relatively long-lived species (some to 35 years). Sablefish probably spawn during the spring at some depth, but little is known about their spawning migration or egg-larval development. The eggs are pelagic as are the early prolarvae. Later larvae range to depths of 150 m. Sablefish are indiscriminate feeders on a large variety of benthic and pelagic organisms.

(f) **Pacific Halibut (*Hippoglossus stenolepis*):** The largest of the flounder family, Pacific halibut, inhabit much of the proposed sale area. Demersal halibut inhabit depths ranging from 50 to 500 m (Bakkala, 1975). There seems to be some seasonal migrations to shallower waters during the summer. Halibut in the commercial fishery range to 90 kg (200 lb), but 11 to 14 kg (25-30 lb) is more common. The species is long-lived—35 years is not uncommon. Little is known of the early life history of the species. It is thought that spawning occurs in the deeper Gulf of Alaska waters during the winter and possibly over a relatively long period, depending on the size of the females. The eggs hatch in about 15 days, depending on water temperature. The early larvae are pelagic, assuming benthic existence after about 6 months (Bakkala, 1975).

Pacific halibut prey on a variety of other benthic fishes, crustaceans, and mollusks. Current biomass estimates for this species in the Gulf of Alaska is about 262.6 million pounds (International Pacific Halibut Commission, 1991)

(g) **Other Groundfish:** Lesser numbers of arrowtooth flounder, yellowfin sole, Atka mackerel, and other less-significant groundfish inhabit the lower Cook Inlet region. These species generally are in the same habitats as the previously discussed groundfish species and, therefore, likely would be similarly affected by the proposed action.

3. **Marine and Coastal Birds:** General descriptions of the distribution, abundance, and biology of marine and coastal birds may be found in the Gulf of Alaska/Cook Inlet Sale 88 FEIS (USDOI, MMS, Alaska OCS Region, 1984), the Lower Cook Inlet-Shelikof Strait Sale 60 FEIS (USDOI, BLM, Alaska OCS Office, 1981), and references cited. These documents are summarized and incorporated by reference and updated by additional references, as cited.

Approximately 100 species of marine and coastal birds occur regularly in the proposed lower Cook Inlet sale area, including 39 seabirds; 35 loons, grebes, and waterfowl; and 28 shorebirds (Gabrielson and Lincoln, 1959; Isleib and Kessel, 1973; Erikson, 1976; Kessel and Gibson, 1978; Sowls, Hatch, and Lensink, 1978; Sowls et al., 1982). The most abundant breeding seabirds are the Leach's and fork-tailed storm petrels, the glaucous-winged gull, black-legged kittiwake, common murre, and horned and tufted puffins. Among waterfowl and shorebird species, the pintail, oldsquaw, white-winged scoter, dunlin, and western sandpiper are the most abundant in the gulf region. Common or abundant marine and coastal birds that are resident or migrant species in the lower Cook Inlet area are listed in Table III.B.3-1.

Within the lower Cook Inlet area, the largest concentration of seabirds occurs in the Barren Islands, where over 650,000 have nested (Sowls, Hatch, and Lensink, 1978). Another large colony or concentration is found on the Chisik-Duck Islands (about 78,000 birds) (see Graphic 1). Other colony concentrations occur immediately south of the sale area in Puale and Dry Bays (161,000) and in the area north of Amber Bay (98,000) adjacent to the lease area's south Shelikof Strait boundary. Smaller colonies are present in Kamishak Bay and on northwestern Afognak and western Shuyak Islands (Sowls, Hatch and Lensink, 1978; Bailey and Faust, 1982). Kachemak Bay recently was identified as a Western Hemisphere Shorebird Reserve due to its importance to shorebirds of the Pacific Flyway.

a. **Seasonal Distribution:**

(1) **Spring (April-May):** The highest coastal bird density occurs in the lower Cook Inlet area in spring (Table III.B.3-2) when large numbers of waterfowl and shorebirds migrate through this area, swelling the substantial numbers of overwintering waterfowl and gulls present (Arneson, 1980). Arneson (1980) recorded densities of >300 birds per square kilometer (/km^2) in Tuxedni Bay and over 400/km^2 in southern Kamishak Bay; a majority of the latter were shorebirds and sea ducks. Other areas with substantial bird concentrations include inner Kachemak Bay (mainly sea ducks and diving ducks, shorebirds, and gulls); Redoubt Bay (mainly shorebirds, geese, and ducks); and the Iniskin-Iliamna Bay (mainly shorebirds and diving ducks) (Table III.B.3-2). The greatest variety and numbers of birds occur in exposed inshore waters and the various habitats associated with bays and lagoons including open water, tidal mudflats, deltas, floodplains, and saltmarshes (USDOI, MMS, Alaska OCS Region, 1984). Loons, grebes, cormorants, sea ducks, and alcids are most frequently found on bays and exposed inshore waters. Geese and dabbling ducks primarily use river floodplains and marshes, while diving ducks spend most of their time on bay waters. Shorebirds are found primarily on mudflats and gravel areas. Gulls use a variety of habitats, especially those associated with lagoons.

Table III.B.3-1

Common or Abundant Marine and Coastal Birds that are Resident or Migrant in the Cook Inlet/Shelikof Strait Area

Seabirds	Waterfowl	Shorebirds
Sooty Shearwater	Pintail	Dunlin
Short-Tailed Shearwater	Oldsquaw	Black Oystercatcher
Leach's Petrel	Common Eider	Western Sandpiper
Forked-Tailed Storm Petrel	Common Goldeneye	Least Sandpiper
Glaucous-Winged Gull	Common Merganser	Red Phalarope
Black-Legged Kittiwake	Red-Breasted Merganser	Greater-Yellowleg
Common Murre	Harlequin Duck	Lesser Yellowleg
Thick-Billed Murre	Greater Scaup	Rock Sandpiper
Horned Puffin	Mallard	Common Snipe
Tufted Puffin	Gadwall	Short-Billed Dowitcher
Northern Fulmar	American Wigeon	American Golden Plover
Pigeon Guillemot	Green-Winged Teal	Black-Bellied Plover
Pelagic Cormorant	Arctic Loon	Pectoral Sandpiper
Redfaced Cormorant	Common Loon	Wandering Tattler
Double-Crested Cormorant	Red-Throated Loon	Pomerine Jaeger
Marbled Murrelet	Horned Grebe	Parasitic Jaeger
Ancient Murrelet	Canada Goose	
Kittlitz's Murrelet	Pacific Black Brant	
Crested Auklet	Emperor Goose	
Rhinoceros Auklet		
Parakeet Auklets		
Cassin's Auklet		
Arctic Tern		
Aleutian Tern		
Mew Gull		

Source: USDOI, MMS, Alaska OCS Region, 1993.

Table III.B.3-2
Seasonal Bird Densities in Lower Cook Inlet

Season	Density in Square Kilometers	
Spring (April-May)		
Lower Cook Inlet	192	
Southern Kamishak Bay	417	
Tuxedni Bay	332	(Mainly black-legged kittiwakes on Chisik Island)
Inner Kachemak Bay	262	(Mainly sea ducks, shorebirds, and gulls)
Redoubt Bay	210	(Mainly geese, ducks, and shorebirds)
Iniskin-Iliamna Bay	206	
Summer (June-August)		
Lower Cook Inlet	130	
Tuxedni Bay	538	
Augustine Island	254	
Kachemak Bay	200	
Southwest Kamishak Bay	200	
Outer Kachemak Bay	93	
Iniskin-Iliamna Bay	96	
City of Kenia area	155	(Mostly gulls)
Chugach Islands	92	
Fall		
Lower Cook Inlet	66	
Tuxedni Bay	111	
Inner Kachemak Bay	152	
Southwest Kamishak Bay	125	
Northwest Kachemak Bay	105	
Winter		
Lower Cook Inlet	32	
Eastern Cook Inlet	47	
Western Cook Inlet	16	
Tuxedni Bay	81	
Inner Kachemak Bay	99	
Outer Kachemak	52	
Chugach Islands	48	

Source: Arneson, 1980; USDOI, MMS, 1984.

[1] Average density.

(2) **Summer (June-August):** Bird density in lower Cook Inlet coastal habitats decline between spring and summer (Table III.B.3-2). Departure of shorebirds and waterfowl accounts for most of this decline. Densities of cormorants, gulls, and alcids increase in summer (Arneson, 1980). The most common seabirds during June are alcids, particularly murres, and also murrelets; shearwaters, fulmars, and storm petrels also are common (Agler et al., 1994). During June, an estimate of about 798,000 marine birds were counted in lower Cook Inlet, with the highest density of 152.9 birds/km^2 within 200 m of shore, 71.6 birds/km^2 within 3 nmi but more than 200 m of shore, and 50.7 birds/km^2 beyond 3 nmi of shore (Agler et al., 1994; 1995). The highest summer density in western Cook Inlet occurs in Tuxedni Bay (Table III.B.3-2). As in spring, the Chisik Island kittiwake colony accounts for the majority of the nesting seabirds on the western side of the Inlet. However, both black-legged kittiwake and common murre colonies on Chisik and Duck Islands have declined drastically over the past 30 to 50 years, with kittiwakes declining from about 25,000 to about 14,000 adult birds, while common murres have declined by perhaps as much as 90 percent since 1970 (Slater, Nelson, and Ingrum, 1994).

Bird densities for Kachemak Bay and southwest Kamishak Bay are over 200/km^2, with gulls and sea ducks being the major species groups (Arneson, 1980; Table III.B.3-2). Sea ducks are abundant in the Iniskin/Iliamna Bay area and outer Kachemak Bay, and the high densities of gulls occur near Kenai and in the Chugach Islands. During June, marine birds are distributed throughout lower Cook Inlet, with concentrations of more pelagic species such as shearwaters, murres, and murrelets occurring in the eastern half of Cook Inlet near the entrance to Kachemak Bay (Agler et al., 1994; 1995). Concentrations of marbled murrelets generally occur within bays and fiords on the eastern side of Kodiak and Afognak Islands, but also along the coast of lower Kenai Peninsula, Kachemak Bay, Shuyak Island, and Hallo Bay on the south side of the Alaska Peninsula (Piatt and Naslund, 1995).

(3) **Fall:** Average bird densities in fall are only one-third to one-half of those observed in spring and summer (Table III.B.3-2). Departure of gulls and sea ducks accounts for most of the decline. By October, most alcids already have departed for pelagic waters. Only dabbling duck and goose densities increase in fall, as migrating birds move into the area. Fall densities exceeded 100 birds/km^2 in four areas of Cook Inlet: inner Kachemak Bay, southwestern Kamishak Bay, Tuxedni Bay, and northwestern Kachemak Bay. Dabbling ducks, sea ducks, and gulls account for 85 percent of total birds observed. Habitat use in fall is similar to that in spring and summer; habitats associated with bays and lagoons are used most heavily (Arneson, 1980).

(4) **Winter:** Overall winter bird density in lower Cook Inlet is less than half that observed in fall (Table III.B.3-2). A large decrease in gull density, together with the departure of migrant waterfowl, accounts for most of the decline. Sea ducks, primarily scoters, are the most abundant group remaining in winter (Agler et al., 1995). Winter bird densities are higher in eastern Cook Inlet than on the western side. Inner Kachemak Bay has the highest density (Table III.B.3-2), with ducks making up most of this total. Birds reported by Agler et al., (1995) in Kachemak Bay primarily are sea ducks (52% of these were scoters) and alcids (63% of these were murres and 29% murrelets). On the western side of the inlet, the highest density occurs in Tuxedni Bay, while no other area on the western side of Cook Inlet exceeds 27 birds/km^2 in winter (Arneson, 1980). Coastal habitats used most heavily in winter are bays, exposed inshore waters, mudflats, and lagoons. Sea ducks are the most prevalent group, comprising 47 percent of total birds counted.

The Shelikof Strait/Kodiak Island area is recognized as an important wintering ground for several waterfowl and seabird species (Forsell and Gould, 1981; Zwiefelhofer and Forsell, 1989; Piatt and Naslund, 1995). Forsell and Gould (1981) estimated that about 40,000 cormorants, 65,000 oldsquaw, 13,000 king eiders, 35,000 white-winged scoters, 30,000 black scoters, 200,000 common murres, 17,800 murrelets, and 50,000 crested auklets wintered in the Kodiak/ Shelikof Strait region. Estimates for other species groups include 11,500 dabbling ducks, 35,000 sea ducks, 10,000 gulls, and 8,500 alcids (approximately 516,000 total). About 77,000 fulmars, 65,000 black-legged kittiwakes, 45,000 glaucous-winged gulls, and 800,000 common murres winter over the Kodiak shelf. The most abundant birds wintering in Uyak and Uganik Bays on the western side of Kodiak Island are common murres, oldsquaw, black scoters, white-winged scoters, marbled murrelets, pelagic and red-faced cormorants, crested auklets, mew gulls, and harlequin ducks (Zwiefelhofer and Forsell, 1989; Piatt and Ford 1994; Piatt and Naslund, 1995). Concentrations of marbled murrelets occur in sheltered waters of bays, fiords, islands, and straits off Kodiak and Afognak Islands adjacent to coastal coniferous forests (Piatt and Naslund, 1995). Annual winter surveys of Uyak and Uganik Bays on the western shore of Kodiak Island since 1980 indicate that overwintering populations of marbled murrelets, loons, cormorants, mew gulls, and common murres are stable, while pigeon guillemot numbers have declined by 50 percent in the past 15 years (Zwiefelhofer, 1995).

Arneson (1980) found an average winter density of 39 birds/km^2 in the Kodiak area. Forsell and Gould (1981) found 40.2 birds/km^2 in Shelikof Strait (November-December) and 64.0 to 68.6 birds/km^2 in the northwestern Kodiak Island area (equivalent to about 75,000 birds in three northwestern bays). In late winter (February-March), these densities increase to 114.5 birds/km^2 on northwestern Kodiak Island. The most abundant groups (November-December) are cormorants, scoters, gulls, murres, murrelets, and puffins. Large concentrations of crested auklets have been reported in the Kupreanof Strait/Whale Pass area of Kodiak during the winter (Dick and Donaldson, 1978).

b. **Food Sources-Trophic Relationships:** Five major prey species have been identified for seabirds during the spring and summer seasons for the western Gulf of Alaska/lower Cook Inlet area. They include capelin, pollock, sand lance, euphausiid crustaceans, and squid (Baird, 1991; Hatch, 1984; Sanger, Hironaka, and Fukuyama, 1978; Baird and Moe, 1978). Fish, specifically capelin, may be the most important food source for pelagic bird species on the eastern side of Kodiak Island during the spring and summer. Many of the common species, such as murres and puffins, probably are opportunistic in their foraging habits and may concentrate on whatever prey species of appropriate size are most abundant in the area.

Available information on the winter food habitats of sea ducks and alcids in Kachemak Bay indicate that sea ducks and alcids use several food items (Sanger, Jones, and Wiswar, 1979; Sanger and Jones, 1984; Sanger, 1987). Sea ducks feed primarily on benthic invertebrates, with clams and mussels important for oldsquaw and scoters, respectively. Common murres use a variety of crustaceans, fishes, and polychaetes (Sanger, Jones, and Wiswar, 1979; Krasnow, Sanger, and Wiswar, 1979). In general, waterfowl wintering in Kachemak Bay feed on surf clams and blue mussels; scoters feed on at least 22 species of prey, mostly clams, mussels, and snails (Sanger and Jones, 1984). The most important winter prey of marbled murrelets in Kachemak Bay is capelin (Sanger, 1987).

c. **Migration:** Seasonal shifts in avian populations in the proposed Sale 149 area largely are a result of bird migration. Numbering in the millions, pelagic birds (shearwaters, petrels, and fulmars), gulls, waterfowl, and shorebirds are the primary groups that migrate through the area. The spring migration begins in late March and peaks from late April to early May (Erikson, 1976; Gill, Handel, and Petersen, 1978).

Large migratory breeding populations inhabit the Barren Islands and other seabird colonies. Millions of subadult seabirds spend the summer season in the western Gulf of Alaska/lower Cook Inlet area. Several million waterfowl and shorebirds move through the sale area in the spring. Important staging areas are located at Kachemak Bay, Douglas River mudflats, Kenai River mudflats, Tuxedni Bay, the Drift River, Chinitna Bay, Iliamna Bay, Ursus Cove, and other areas in lower Cook Inlet (Erikson, 1976). Use of bays and inlets in Shelikof Strait by migratory birds, especially along the Alaska Peninsula, is little known. Katmai Bay area on the west side of Shelikof Strait is an important area for several species of sea ducks and shorebirds, including white-winged scoters, greater scaups, Barrow's goldeneyes, harlequin ducks, black turnstones, and greater yellowlegs (Cahalane, 1944).

Fall-migration movements in lower Cook Inlet begin in July and end in November. Shorebirds are the first to move into the sale area and probably the last to leave (Gill, Handel, and Petersen, 1978). By August, waterfowl begin to move south through the area, and wintering sea ducks begin to arrive. By early October, most breeding migrants and nonbreeding summer-season migrants have left.

d. **Coastal Birds of Prey:** The two major coastal birds of prey in the sale area are the bald eagle and the peregrine falcon. The bald eagle is a breeding, year-round resident along the coasts of lower Cook Inlet and Shelikof Strait. This species is very common along the coast of Kodiak, Afognak, and Shuyak Islands; the Alaska Peninsula; and the southern Kenai Peninsula (USDOI, FWS, 1989-1990). During the 1980's, nearly 2,000 eagle nests were counted along the coasts with over 1,400 nests on Kodiak, 298 nests on southern Kenai Peninsula, 277 nests on the south side of the Alaska Peninsula, and 90 nests on the coast of Katmai National Park (Schempf, 1992). Bald eagles appear to be more abundant on the Shelikof Strait side of Kodiak than on the eastern side of the island (USDOI, FWS, 1989-1990). The recent estimate of the total population for the Kenai Peninsula, Kodiak, and the southern side of the Alaska Peninsula area is about 4,000 eagles (Schempf and Bowman, 1991). Bald eagles feed primarily on fish or act as scavengers.

Peales peregrine falcons nest regularly at scattered coastal locations around the Kodiak Archipelago. This subspecies is not listed threatened or endangered. Some nesting is known to occur on the Barren Islands (Bailey, 1976). Peregrines frequent the heads of bays where they prey on waterfowl and shorebirds.

4. Nonendangered Marine Mammals (Pinnipeds, Cetaceans, and the Sea Otter):

This section summarizes pertinent information from the EIS's for Lower Cook Inlet/Shelikof Strait Sale 60, St. George Basin Sale 70, North Aleutian Basin Sale 92, Gulf of Alaska/Cook Inlet Sale 88, and Navarin Basin Sale 107 (USDOI, BLM, Alaska OCS Office, 1981; USDOI, MMS, Alaska OCS Region, 1982, 1985, 1984 and 1991 final EIS's, respectively) and is supplemented by additional new information where cited.

Fifteen species of nonendangered marine mammals are resident or occur seasonally in lower Cook Inlet (Table III.B.4-1). Of these, the sea otter (*Enhydra lutris*) and the Pacific harbor seal (*Phoca vitulina*) are the most common and occur in substantial numbers throughout the region. Of the 10 nonendangered cetaceans recorded from the sale area, 6 are common or abundant during part of the year. The distribution, abundance, and ecology of marine mammal species commonly found or seasonally abundant in this region are summarized in the sections below. Marine mammal species that are uncommon or rare in the sale area are not summarized in the species summary-description sections that follow but are listed for a general overview in Table III.B.4-1.

a. Pinnipeds:

(1) Northern Fur Seal:

Northern fur seals range in the North Pacific from about 32° to 60° N. latitude. The worldwide population is estimated at 1,207,000 (North Pacific Fur Seal Commission, 1984); about 871,000 of these breed on the Pribilof Islands in the Bering Sea. A smaller population of 713 breeds on Bogoslof Island in the Aleutian Islands (Merrick, 1990). There were no significant population changes for most breeding groups from 1981 to 1986 (York and Kozloff, 1987), and the Pribilof Island stock may be stable (Loughlin, 1989). However, recent counts of adult males on St. Paul Island, the estimated number of pups born on St. George Island, and the pup counts on Robben Island in the Sea of Okhotsk have recently declined (USDOC, NOAA, National Marine Fisheries Service [NMFS], 1992a). The NMFS has designated the Pribilof Island population as depleted under the Marine Mammal Protection Act. The status category "depleted" means the population is less than half the estimated level of the 1940's and 1950's in comparison to the estimated maximum net productivity level of 60 percent or more of the carrying capacity of the environment (Fowler, 1984; 1985).

Fur seals are pelagic and come ashore primarily during the summer breeding season. While at sea, they disperse over the continental shelf break. They principally are found within 160 km of the shelf break in the Gulf of Alaska between southeast Alaska and Kodiak Island (Morris, Alton, and Braham, 1983). Most northern fur seals winter in the North Pacific Ocean and summer in the Bering Sea; females and young males regularly migrate through these two areas (Gentry and Holt, 1986). Some older males spend the winter in the Gulf of Alaska (Alexander, 1953). Younger males and females normally overwinter south of Alaska along the continental shelf of British Columbia, Washington, Oregon, and California (Morris, Alton, and Braham, 1983).

Although fur seals occasionally occur in lower Cook Inlet and Shelikof Strait, they primarily are found farther offshore along the continental shelf break. The largest numbers of seals are present during the spring migration as they move to the Pribilof Islands to breed. Some, mostly juvenile, nonbreeding males, remain along the shelf break to the south and southwest of Kodiak Island throughout the summer. Winter sightings are relatively common within 160 km of the shelf break east of Kodiak Island, especially along the edges of Portlock and Albatross Banks (Alexander, 1953). Graphic 2 shows the seasonal distribution of fur seals in Cook Inlet, Shelikof Strait, and the Gulf of Alaska east of Kodiak. Fewer single animals are observed in winter than in other seasons. Groups of >100 individuals have been seen near Chirikof Island and in several other locations throughout the Gulf of Alaska.

The northward migration of individuals wintering in southern parts of the range begins in March and, from April to mid-June, large numbers are found in coastal Gulf of Alaska waters (Consiglieri et al., 1982). By April, the seal-migration front has reached the vicinity of the Albatross Banks off Kodiak Island. Fur seal numbers are highest in the gulf and in the vicinity of the sale area in May, particularly in waters adjacent to Albatross Banks. The greatest concentrations during spring were observed within 160 km of the shelf break between southeast Alaska and southern Kodiak Island, especially towards Kodiak Island (Morris, Alton, and Braham, 1983).

Seal numbers decline in the gulf during summer, as the majority of animals leave to breed on the Pribilof Islands. The younger, nonbreeding individuals remaining in the region are found near the shelf break and in shallower waters east of Kodiak Island and southwest to Unimak Pass. Fur seal densities in the gulf are low during the fall, as the southward migration from the Pribilof Islands begins in October.

Table III.B.4-1
Nonendangered Marine Mammal Species and Relative Frequency of Occurrence in the Vicinity of the Lower Cook Inlet and Shelikof Strait

Species	Frequency of Occurrence
Northern Fur Seal	Occasional
Harbor Seal	Common
Northern Elephant Seal	Uncommon
Pacific Walrus	Uncommon
North Pacific Gray Whale	Seasonally Abundant
Minke Whale	Abundant
Killer Whale	Common
Beluga Whale	Common
Dall's Porpoise	Common
Harbor Porpoise	Common
Pacific White-Sided Dolphin	Seasonally Abundant
Northern Right Whale Dolphin	Uncommon
Baird's Beaked Whale	Uncommon
Cuvier's Beaked Whale	Uncommon
Bering Sea Beaked Whale	Uncommon
Sea Otter	Common

Sources: DeGange et al. (1989, 1990); Dahlheim et al. (1992); Pitcher (1990, 1985); Hoover (1988); Sease and Chapman (1988); Calkins (1986, 1989); Bouchet, Ferraro, and Turnock (1986); Leatherwood et al. (1984); and Morris, Alton, and Braham (1983).

Fur seals congregate in nutrient-rich areas over the continental shelf and slope where upwelling results in an abundance of prey species. They can dive to depths of 200 m but usually stay in the range of 20 to 100 m when foraging (Kooyman, Gentry, and Urquhart, 1976). Fur seals feed on a variety of fish, including capelin, sand lance, pollock, herring, Atka mackerel, and squid (Morris, Alton, and Braham, 1983).

Fur seals are sexually dimorphic for size, with males (140-280 kg) much larger than females (30-50 kg). The maximum lifespan for fur seals probably is 30 years (Morris, Alton, and Braham, 1983). Some females begin breeding at 3 years, but the most productive year-classes are from ages 5 through 13 (Lander, 1981).

(2) **Harbor Seal**: Harbor seals are present in coastal waters throughout the sale area. Although primarily a nearshore species, harbor seals have been sighted up to 100 km offshore (Fiscus et al., 1976). Present in almost all nearshore marine habitats, they concentrate in estuarine and other protected waters (Pitcher and Calkins, 1979). They most frequently haul out on protected habitats including cobble and sand beaches, offshore rocks and reefs, tidal mudflats and sandbars, and floating and shorefast ice (Pitcher, 1977; Pitcher and Calkins, 1979; Frost, Lowry, and Burns, 1982). Harbor seals seasonally frequent freshwater streams and lakes during anadromous fish runs, and some reside in Iliamna Lake year-round (Pitcher and Calkins, 1979; Pitcher, 1985).

In 1973, the Alaska Department of Fish and Game estimated about 55,000 seals for Cook Inlet, Kodiak Island Archipelago, Shelikof Strait, and the south side of the Alaska Peninsula (Pitcher, 1985). Surveys conducted in 1991 and 1992 estimate minimum population levels of harbor seals in Alaska, based on the sum of maximum counts, at 25,183 animals (Loughlin, 1992). The population estimate for Cook Inlet, including the Barren Islands area, was 2,443. Surveys on Tugidak Island (Pitcher, 1990; 1991) and in Prince William Sound (Pitcher, 1989; Frost et al., 1991) indicate a significant decline in harbor seal abundance since the earlier estimates. Several causes for the decline have been proposed but supporting evidence is sketchy, and more than one factor may be involved. Factors possibly causing the declines include natural population fluctuations or cycles, reduced environmental carrying capacity due to natural or human causes, disease, predation, commercial and subsistence harvests, direct fishery-related mortality, entanglement in marine debris, pollution, and emigration (Hoover-Miller, 1994). Thus, the early estimates probably overestimate the current population level by a substantial margin, and an accurate minimum population estimate therefore is not available (USDOC, NOAA, NMFS, 1992a).

Major harbor seal-haulout sites in the region of the sale area include Kamishak Bay in lower Cook Inlet and Sitkinak and Tugidak Islands at the southern end of Kodiak Island (Graphic 2; Loughlin, 1992; Hoover, 1988). A minimum of 10 minor harbor seal-haulout sites and pupping areas (< 100 seals) exist in bays adjacent to Shelikof Strait. Pupping occurs at most major haulouts and varies temporally from May through July in Alaska. Pups are born in June on Tugidak Island and from May to June in Prince William Sound. Harbor seals molt following the reproductive period, with the peak season for molting from July to September for Gulf of Alaska seals (Pitcher and Calkins, 1979).

Harbor seals are opportunistic feeders, their diet varying with season and location. In the Gulf of Alaska, pollock, octopus, capelin, eulachon, and herring comprised the most volume in harbor seal diets, followed by cods flatfishes, shrimp, salmon, and squid (Hoover, 1988).

b. Cetaceans:

(1) **Gray Whale**: Since receiving protection by the International Whaling Commission (IWC) in 1946, the eastern Pacific gray whale population has increased from a few thousand individuals surviving commercial harvest to more than 21,000 (Breiwick et al., 1989; Withrow, 1989; USDOC, NOAA, NMFS, 1991a). Evidence that this population is approaching or may have exceeded pre-exploitation levels (Rice, Wolman, and Braham, 1984) has resulted in its removal from the List of Endangered and Threatened Wildlife (59 *Federal Register* [*FR*] 31094, June 16, 1994).

Most gray whales calve and breed from late December to early February in protected waters along the west coast of Baja California. Recent observations suggest that some calving occurs as far north as Washington prior to arrival on the calving grounds (Dohl et al., 1983; Jones and Swartz, 1987).

Northward migration, primarily of individuals without calves, begins in February; some cow/calf pairs delay their departure from the calving area until well into April (Jones and Swartz, 1984). A majority of gray whales migrating through the Southern California Bight follow routes near the mainland or Channel Islands and nearshore waters of coastal Mexico during both spring and fall migrations. Most whales occur within 15 km of land but have been observed up to 200 km offshore (Bonnell and Dailey, 1990). Much of the migration route north of Point Conception to and from summer feeding grounds in the northern Bering and southern Chukchi Seas lies within a few kilometers of the coast or adjacent islands. Gray whales approach the Sale 149 area along the perimeter of the Gulf of Alaska in April, May, and June and again in November and December (Rice and Wolman, 1971). Although there have been numerous sightings of gray whales in Shelikof Strait, most of the population follows the outer coast of the Kodiak archipelago from the Kenai Peninsula in spring or Alaska Peninsula in fall (Graphic 3). Spring concentrations occur along eastern Afognak Island and northeastern, central, and southeastern Kodiak Island. A few gray whales may overwinter in the Gulf of Alaska region (Berzin and Rovnin, 1966), and an unknown number summer along the west coast of North America (56 *FR* 58870).

Gray whales feed primarily in the northern Bering and southern Chukchi Seas during the summer months. Benthic amphipod crustaceans appear to be the primary prey species; polychaete worms, mollusks, and schooling fish also are taken (Rice and Wolman, 1971).

(2) **Minke Whale:** The North Pacific minke whale (*Balaenoptera acutorostrata*) population extends from equatorial waters north into the Chukchi Sea. This species, though commercially harvested by Japan (Mitchell, 1978), has never been harvested intensively in the eastern North Pacific. Therefore, it is assumed to be at carrying capacity (Rice, 1971) and is considered abundant (Calkins, 1986).

Over 95 percent of all minke sightings in the NMFS database have occurred within the 200-m-depth contour, and most of those were in shallow water (Morris, Alton, and Braham, 1983). In spring, most minke whales are found over the continental shelf, especially in shallow nearshore coastal waters. During the summer months, minke whales are most numerous in the Gulf of Alaska and over the continental slope of the Bering Sea (USDOC, NOAA, NMFS, 1992a). They appear to become more sedentary and apparently are concentrated near Kodiak Island, in Prince William Sound, and in the northeast gulf including Yakutat Bay (Rice and Wolman, 1982). Most minke whales probably leave the region by October, because they become scarce in the gulf in fall and winter (Consiglieri et al., 1982).

Migratory patterns of the minke whale in the eastern North Pacific are not well defined. In the western North Pacific, they migrate northward in early spring and southward in the fall, with some sex and age segregation in the migration. Adults and some adolescents travel to northernmost feeding areas, and most immature individuals remain in southern waters (Omura and Sakiura, 1956).

Minke whales are opportunistic and feed on locally abundant fish and crustacean species. North Pacific minkes consume euphausiids, swarming fish (such as pollock, herring, and sand lance), and copepods in decreasing order of preference (Morris, Alton, and Braham, 1983).

(3) **Killer Whale:** Killer whales (*Orcinus orca*) are found in all oceans and contiguous seas throughout the world (Leatherwood and Dahlheim, 1978). Killer whales are typically found in pods of 2 to 50 individuals (Bigg, 1982). Their concentrations in Alaska are near landmasses and the continental shelf—in Prince William Sound, near Kodiak Island, around the Aleutian Islands, and in southeast Alaska (Braham and Dahlheim, 1982). A minimum population estimate for killer whales in Prince William Sound, Shelikof Strait, and Southeast Alaska is 286 whales, with about 100 whales estimated for Shelikof Strait (Leatherwood et al., 1984). More recent data indicate as much as 251 photoidentified whales in Prince William Sound, but it is likely that some of those whales were from Kodiak (Matkin, Steiner, and Ellis, 1989; Matkin and Ellis, 1990).

In spring, killer whales are found throughout the gulf in shallow waters <200 m deep. In summer, they apparently are more concentrated in the south, east, and northeast (Portlock Bank) of Kodiak Island, in Prince William Sound, and in nearshore waters of southeast Alaska. Movement of killer whales in nearshore waters in summer and fall is related to inshore migrations of pelagic fish, such as salmon and other schooling fish, which are common prey species in these areas (Balcomb et al., 1980). In fall and winter, killer whales are numerous around Kodiak and in adjacent shelf waters but not elsewhere in the gulf. Groups are larger in spring and summer than in fall or winter. Group size varies from 1 to 100 whales; one aggregation estimated to contain 500 animals was observed near Middleton Island in April 1972 (Morris, Alton, and Braham, 1983).

Killer whales have no natural predators, but they have one of the most diverse diets of all marine mammals (Lowry et al., 1982). They prey on fishes and other marine mammals including salmon, cods, seals, sea lions, walruses, fur seals, whales, and porpoises.

(4) Beluga Whale: Beluga whales (*Delphinapterus leucas*) are the most abundant arctic cetacean, and they inhabit subarctic waters as well. In Alaska, two population groups of beluga whales generally are recognized: (1) the Cook Inlet stock from Kodiak to Yakutat Bay in the Gulf of Alaska and (2) the Western Arctic stock consisting of whales from Bristol Bay and the Bering, Chukchi, Beaufort, and east Siberian Seas (Calkins, 1989). The Cook Inlet stock is listed as a candidate species for protection under the Endangered Species Act of 1973 (53 *FR* 33516). At least 15,800 to 18,450 beluga whales have been estimated to summer in the coastal waters of Alaska and western Canada, not including belugas from Russia and the Chukchi Sea and Beaufort Sea ice fringe (Hazard, 1988).

Most of the Gulf of Alaska population inhabits Cook Inlet, where they are present year-round. Direct counts for belugas in a single day have been as high as 479 and, when a correction factor of 2.7 for submerged animals is applied, the population estimate for Cook Inlet is 1,293 (Calkins, 1989). But recent aerial surveys have detected 242 belugas on a single day, providing a current estimate of 653 for the inlet population after applying the correction factor (USDOC, NOAA, NMFS, 1992b). (A NMFS unpublished report currently estimates the population at 898). Elsewhere in the gulf, belugas have been observed in Shelikof Strait, Marmot Bay, Barren Islands, Montague Island, and Yakutat Bay.

Ice and prey distribution affect the seasonal movements of beluga whales (Calkins, 1986). Additionally, the distribution of belugas in Cook Inlet is strongly influenced by fish availability, especially eulachon (candlefish) and salmon smolt. They generally frequent shallow waters, bays, estuaries, and the mouths of streams (Calkins, 1986). In winter, movements are limited by the combination of ice and strong tides. Although it is not known where belugas winter, it is likely they spend most of the winter in the area south of the Forelands.

Because belugas generally seem confined to Cook Inlet and appear to be stable in number, it may be assumed that the population has reached the carrying capacity of this area (Morris, Alton, and Braham, 1983). If the Cook Inlet population has exceeded carrying capacity and suitable habitat in the Gulf is limited, the Yakutat animals may represent excess individuals from Cook Inlet. Beluga whales have a diverse diet with over 100 different prey species consumed. In Alaska, belugas feed on seasonally abundant anadromous and coastal spawning fishes such as salmon, smelt, capelin, eulachon, herring, and saffron cod (Lowry, 1985). Belugas also may scavenge dead or dying salmon. Tags from salmon tagged high upstream the Susitna River have been found in the stomach of one dead adult beluga (Calkins, 1989). Beluga breeding generally takes place in late spring- early summer, and gestation takes about 15 months.

(5) Dall's Porpoise: Dall's porpoises (*Phocoenoides dalli*) are present year-round throughout the Gulf of Alaska. The largest numbers are reported to occur over the shelf in spring and summer from Kodiak Island to Icy Strait (Pike and MacAskie, 1969). Their distribution is not as highly correlated with water depth in fall and winter, when they are more evenly dispersed over the entire gulf. Dall's porpoises are found throughout the continental shelf and slope except in the shallow, turbid waters of Cook Inlet and Icy Bay (Morris, Alton, and Braham, 1983).

Approximately 444,000 (95%-confidence interval—296,369-592,612) Dall's porpoises inhabit the Gulf of Alaska. This is about three quarters of the 608,000 North Pacific population east of 172° W. longitude and south of the Aleutians (Bouchet, Ferraro, and Turnock, 1986). Most sightings are of groups of 2 to 20 animals; larger groups containing as many as 226 individuals have been reported and, in 1980, a group of 3,000 was observed in Southeast Alaska.

Dall's porpoises appear to make seasonal distributional shifts. In Japan, they show both north-south and summer-winter movement (Kasuya, 1982). Seasonal nearshore-offshore movements have been observed in California (Leatherwood and Fielding, 1974) and Prince William Sound (Hall, 1979). Although adults with calves have been seen in spring in the North Pacific, most births and breeding probably occur from June to August (Newby, 1982).

Electrophoretic data indicate some population structuring, with the Bering Sea and North Pacific animals representative of different breeding groups (Winans and Jones, 1988).

Dall's porpoises primarily eat squid (family *Gonatidae*) and fishes (29 species), the major proportion of which were lanternfish (*Myctophidae*) (Jones et al., 1980).

(6) **Harbor Porpoise**: There are two stocks of harbor porpoises (*Phocoena phocoena*) in Alaska, one in the Bering Sea and the other in the Gulf of Alaska south to Prince of Wales Island (Gaskin, 1984). They inhabit coastal areas throughout the Gulf of Alaska and are considered abundant based on the amount of suitable habitat (Morris, Alton, and Braham, 1983). However, comprehensive surveys for the harbor porpoises in the gulf and throughout the North Pacific are lacking. Recently, Dahlheim et al. (1992) performed aerial surveys in Cook Inlet and Bristol Bay and estimated 4,946 (95%-confidence interval—2,864-7,028) harbor porpoises for both regions combined.

Harbor porpoise sightings are numerous in the Kodiak Island area, Kachemak Bay, Prince William Sound, Yakutat Bay, and Southeast Alaska in spring and summer. Although harbor porpoises are assumed to be year-round residents where they occur, sightings are much less frequent in fall and winter in areas where they are common in spring and summer. Harbor porpoises usually occur singly or in pairs.

Harbor porpoises generally are observed in harbors, bays, and river mouths. They also are seen concentrated in and along turbid river water plumes (e.g., Copper River) and in Icy Bay (Morris, Alton, and Braham, 1983). Their migratory movements are not well defined, but Gaskin, Arnold, and Blair (1974) predicted movement inshore in summer and offshore in winter for harbor porpoises in the Canadian western Atlantic. In Prince William Sound, Hall (1979) estimated 590 harbor porpoises in winter and 946 in summer, suggesting winter dispersion after the summer maxima. Thus, seasonal shifts in distribution also could occur in lower Cook Inlet.

Harbor porpoises feed primarily on small cod and herring (Morris, Alton, and Braham, 1983) and probably capelin, pollock, and eulachon in the Gulf of Alaska (Calkins, 1986).

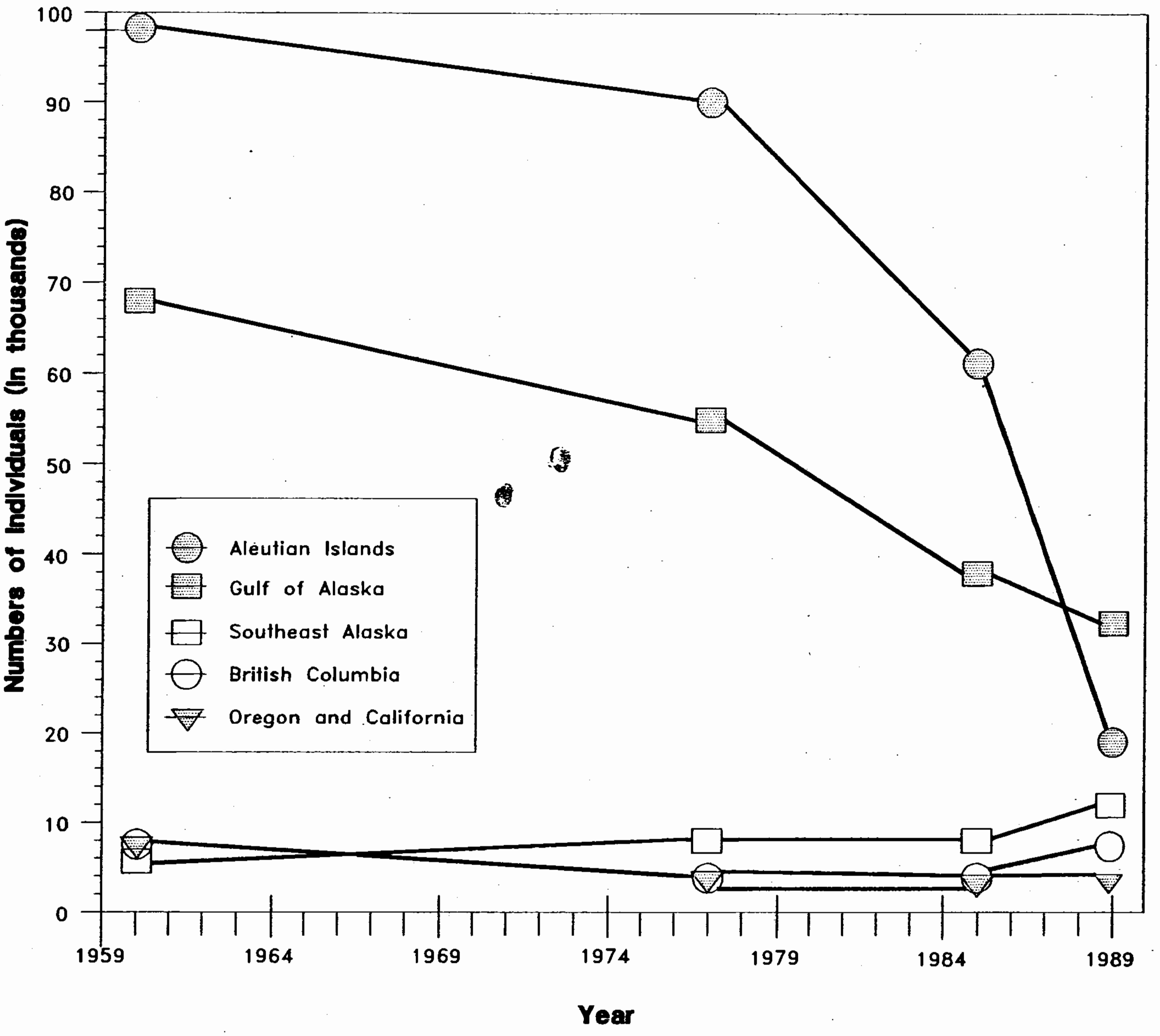
(7) **Pacific White-Sided Dolphin**: There are no population estimates for the Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) in Alaska, but it is regarded as seasonally abundant (Morris, Alton, and Braham, 1983). Though seasonal movements cannot be unequivocally demonstrated for any region, observed peaks in abundance suggest seasonal shifts into waters north of 40° N. latitude, in spring and summer (Leatherwood et al., 1984). In Alaska, they are present but rare in winter, becoming increasingly abundant in spring. They are most abundant in the gulf in summer in areas of high fish concentration, such as the Fairweather Ground in the northeast Gulf of Alaska and Portlock Bank near Kodiak Island. The most frequent sightings of Pacific white-sided dolphins in the Gulf of Alaska coincide with periods of fishing and research activities. So the apparent seasonal movements could be an artifact of the observational effort (Leatherwood et al., 1984).

Pacific white-sided dolphins are frequently observed in groups exceeding 100 individuals, and groups estimated to contain 500 to 2,000 individuals have been sighted. Most sightings have been made over the continental slope in waters 200 to 2,000 m deep (Morris, Alton, and Braham, 1983).

There is little information regarding the feeding habits of Pacific white-sided dolphins in the gulf but in more southern latitudes, they feed on schooling fishes such as anchovies and hake as well as squid (Leatherwood and Reeves, 1978).

c. **Sea Otter**: Sea otters inhabit the coastal waters of the North Pacific Ocean and southern Bering Sea <90 m deep; highest densities usually are found within the 40-m isobath where young animals and females with pups forage. Preferred habitat includes rocky reefs, offshore rocks, and kelp beds (USDOI, MMS, Alaska OCS Region, 1988). Sea otters rest and forage in the vicinity of kelp beds but can occupy areas without kelp (Rotterman and Simon-Jackson, 1988; Kenyon, 1969). They will haul out on rocky points, islets, sandy beaches, and even tidally exposed sandbars. In some cases, 200 to 300 individuals (likely males) will haul out on sandbars.

Near the sale area, sea otters are present in particularly high numbers on the Alaska Peninsula from Kamishak Bay to Hallo Bay, in the Kodiak Archipelago, and on the southwestern Kenai Peninsula near Seldovia and English Bay



Source: Loughlin, Perlov, and Vladimirov, 1992.

Figure III.B.5-1. Estimated Number of Nonpup Steller Sea Lions Occupying Five Geographic Areas during Four Census Years.

(Fig. III.B.5-1; DeGange et al., 1989; DeGange and Burns, 1990). Population estimates for the Alaska Peninsula from Chignik northwards through the Shelikof Strait is 8,310 plus/minus standard error (±SE) 1,486. Estimates for the Kodiak Archipelago and the Kenai Peninsula are 13,526 ±SE 1,199 and 2,330 ±SE 279, respectively (DeGange and Burns, 1990). The populations of sea otters of the northern Kodiak Archipelago (Afognak, Shuyak, and the Barren Islands) may have reached carrying capacity and appear to be food limited (Kvitek et al., 1992).

Potential high-use areas for sea otters in the sale area are along the south side of the Alaska Peninsula from Cape Douglas south to Kukak Bay, and in Kujulik Bay; on the Kodiak Archipelago, between Afognak and Kodiak Islands in the Kupreanof Strait; and on the western end of the Kenai Peninsula (Allen, 1992).

Sea otters generally inhabit nearshore waters with sandy or rocky seafloor that can support populations of benthic invertebrates. They eat a wide variety of benthic invertebrates including sea urchins, abalone, mussels, clams, crustaceans and, in some cases, sluggish epibenthic fishes (Rotterman and Simon-Jackson, 1988).

5. **Endangered and Threatened Species:** Endangered (E), threatened (T), proposed (P), or delisted species that occur in the Sale 149 area, or may enter the area with varying frequency, include the following:

Common Name	Status	Common Name	Status
Steller sea lion	T	Short-tailed albatross	E
Fin whale	E	American peregrine falcon	E
Humpback whale	E	Arctic peregrine falcon	D
Sei whale	E	Aleutian Canada goose	T
Blue whale	E	Steller's eider	P
Right whale	E		
Sperm whale	E		

Transportation of oil from the sale area to ports in the lower 48 will involve tankers transiting southern areas (Washington [WA], Oregon [OR], and California [CA]), where the following additional endangered or threatened species, or those proposed for such status, may occur:

Common Name	Status	Common Name	Status
Guadalupe fur seal (CA)	T	Marbled murrelet (WA, OR, CA)	T
Southern sea otter (CA)	T	Green sea turtle	E
Bald eagle (WA, OR, CA)	T, E	Leatherback sea turtle	E
Brown pelican (CA)	E	Loggerhead sea turtle	T
Light-footed clapper rail (CA)	E	Pacific ridley sea turtle	E
California clapper rail (CA)	E		
California least tern (CA)	E		

General descriptions of the distribution, abundance, and biology of these species may be found in the Cook Inlet/Shelikof Strait Biological Evaluation prepared for Endangered Species Act Section 7 consultation (Appendix I), the OCS Natural Gas and Oil Resource Management Comprehensive Program 1992-1997 FEIS (USDOI, MMS, Herndon, 1992), and the Gulf of Alaska/Cook Inlet Sale 88 FEIS (USDOI, MMS, Alaska OCS Region, 1984) and Lower Cook Inlet-Shelikof Strait Sale 60 FEIS (USDOI, BLM, Alaska OCS Office, 1981), and references cited. The following accounts are summarized from these documents, which are incorporated by reference and updated by additional references as noted.

a. Cetaceans:

(1) **Fin Whale:** The North Pacific fin whale population, protected from commercial harvest by the IWC since 1976, currently exceeds 16,000 individuals (USDOC, NOAA, NMFS, 1988; 1991a), less than half the estimated pre-exploitation population. Distribution and abundance in the western Gulf of Alaska are not well known.

Summer distribution of fin whales extends from central California to the Chukchi Sea. In Alaska, some whales spend the summer feeding over the continental shelf in the Gulf of Alaska, including portions of lower Cook Inlet, Shelikof Strait, outer banks of the Kodiak archipelago, and along the Alaska Peninsula (Graphic 3). Based on commercial-catch statistics, fin whales may be showing site fidelity to Alaska Peninsula waters and the area between the Shumagin and Trinity Islands, but the numbers inhabiting these areas are substantially below historic levels (Brueggeman et al., 1987).

Fall migration occurs from September to November with some fin whales consistently wintering in the Kodiak Island area, primarily observed in bays and inshore waters from northwestern to southwestern Kodiak Island (Zwiefelhofer, 1993, personal comm.) and possibly the Gulf of Alaska; however, most of the North Pacific population is believed to winter far offshore at latitudes from central California to Baja California. Peak breeding period for this species extends from November to February. Northward migrating fin whales enter the Gulf of Alaska from March to June, and peak occurrence in the Kodiak Island-northern Gulf of Alaska area is reached by May (Fiscus et al., 1976; Berzin and Rovnin, 1966). Fin whales feed primarily on euphausiid crustaceans, herring, and capelin (Nemoto, 1970).

(2) Humpback Whale: The eastern North Pacific humpback whale population, estimated to number about 2,000 individuals (USDOC, NOAA, NMFS, 1988), remains greatly depleted from precommercial whaling levels of about 15,000 (Rice, 1978). Humpbacks were protected from commercial harvest by the IWC in 1966. Abundance in summer from the Shumagin Islands to Cook Inlet has been estimated at 1,247 whales (Brueggeman et al., 1988).

Wintering humpbacks that breed and calve from October to March off Mexico occupy summer feeding grounds extending from the Farallon Islands of central California to the Chukchi Sea in Alaska. Currently, it is thought that a majority of North Pacific humpbacks, including those summering in Alaska, winter in Hawaiian waters (Baker et al., 1986; USDOC, NOAA, NMFS, 1988; 1991b). Small numbers have been observed in bays of western and northwestern Kodiak Island (Zwiefelhofer, 1993, personal comm.). The limited data available suggest that waters along the south side of the Alaska Peninsula to the eastern Aleutians may be of particular importance to summering humpbacks (Brueggeman et al., 1987). Whales are present in this area from July to November with peak numbers in July and August. Substantial numbers of humpbacks have been sighted between the Kenai Peninsula and Afognak Island (Rice and Wolman, 1981). In the Barren Islands, as many as 50 individuals have been sighted simultaneously, with at least 100 present in local areas (Roseneau, 1994, personal comm.). Humpbacks are estimated to be present in this area from mid-May until late August or September. A large proportion of the summering population forages over the continental shelf (Graphic 3). Northward migration from Mexican waters begins in March and April. Spring migrants have been observed in March in southeast Alaska, and occurrence over Portlock and Albatross Banks east of the Kodiak archipelago peaks in May. Fall migration from the Gulf of Alaska usually starts in December. Mating and calving occur from October to March on the southern range off Mexico and Hawaii. Humpback whales feed primarily in summer on euphausiid crustaceans and occasional herring, cod, and pollock (Wolman, 1978).

(3) Sei Whale: The North Pacific sei whale population is estimated at 9,110 individuals (Horwood, 1987; USDOC, NOAA, NMFS, 1988, 1991a); a definite trend for this species since its protection by the IWC in 1976 (Mizroch, Rice, and Breiwick, 1984) is not evident.

Sei whales are found offshore in the Gulf of Alaska and south of the Aleutian Islands in summer (Graphic 3), with numbers peaking in May and June. Southward migration begins in August or September; sei whales occur in substantial numbers offshore of central California in late summer and early fall. During January to March, most are found off Baja California but range north to Point Piedras Blancas in central California. Calving occurs from September to February, peaking in November, while most breeding occurs from October to March with a peak in December. Sei whales feed primarily on copepod (*Calanus* spp.) crustaceans; they also eat euphausiid crustaceans, herring, sand lance, and pollock.

(4) Blue Whale: The North Pacific blue whale population as recently as 1988 was estimated at 1,600 individuals (USDOC, NOAA, NMFS, 1988). Recent sightings off Mexico and California (Calambokidis et al., 1990; Reilly and Thayer, 1990) and surveys in California waters (Barlow, 1994) suggest that 2,250 may occupy this area, providing the best estimate since commercial whaling was terminated by the IWC in 1967.

In spring, summer, and fall, blue whales range from California to Alaska. They are present from April or May to October off northern California and Oregon, primarily over the continental shelf and slope from 3 to 80 km offshore. In Alaska, blue whales occur in relative abundance south of the Aleutian Islands and, according to whaling records, large numbers once occurred over Portlock Bank east of Afognak Island. Migration south from the Gulf of Alaska usually begins by September to wintering areas from Baja California to the equator. Blue whales feed primarily on small euphausiid crustaceans.

(5) **Right Whale:** Though sighting information is limited, records suggest there probably are a few hundred right whales remaining in the North Pacific (USDOC, NOAA, NMFS, 1991a). This species was protected by the IWC in 1935.

Whaling records and more recent reports indicate right whales occur in the western Gulf of Alaska, especially east and south of Kodiak Island, and the eastern Aleutians from May to September (Graphic 3). Definitive data are lacking concerning migration, wintering, and breeding; analysis of sighting data suggests that they winter in mid-Pacific (Hawaiian Islands) and western North Pacific waters (Scarff, 1986; USDOC, NOAA, NMFS, 1988, 1991c). Reliable sightings have occurred along the U.S. west coast south to 20° N. (USDOC, NOAA, NMFS, 1991c). Migration probably occurs mainly along a broad front over the continental shelf. Right whales feed primarily on copepod (*Calanus* spp.) and small euphausiid crustaceans.

(6) **Sperm Whale:** The North Pacific sperm whale population is estimated to be 930,000 (USDOC, NOAA, NMFS, 1991a). An estimate for the Gulf of Alaska of 600 has been reported (State of Alaska, ADF&G, 1982).

Typically, sperm whales inhabit deeper waters off the continental shelf from the Equator to the Gulf of Alaska and Bering Sea. Generally, only mature males enter Alaskan waters. They are present mainly in spring, summer, and fall (Graphic 3), undertaking their northward migration from March to June and the southward migration from September to December. Substantial numbers occur regularly east and south of Kodiak Island and west along the Aleutian Islands (Nishiwaki, 1966; Berzin and Rovnin, 1966; USDOC, NOAA, NMFS, 1988). The area occupied in winter generally lies between Hawaii and California. Sperm whales feed primarily on squid and fish.

b. Pinnipeds:

(1) **Steller Sea Lion:** A 1994 census of all Alaskan trend areas produced a count of 33,239 adult/juvenile (nonpup) individuals (NMML, 1995) , a 31-percent decline from numbers counted in 1989 (Loughlin, Perlov, and Vladimirov, 1992), and continuing a decline beginning in the 1960's (Fig. III.B.5-1). In the Kenai to Kiska index area, a decrease of 79 percent since 1976-79, 22 percent since 1989, and 10 percent since 1992 has occurred. Pup production has declined 73 percent since 1984-85, mainly at Chirikof, Marmot, and Sugarloaf Islands (Loughlin, Perlov, and Vladimirov, 1990; Merrick, Loughlin, and Calkins, 1987; Merrick et al., 1991; NMML, 1995). An estimated 4,518 sea lions occupied the Gulf of Alaska area from the Kenai Peninsula to the Shumagin Islands in 1994. Numbers have increased by 41 percent since 1979 in southeast Alaska (estimated nonpup population 9,005) and British Columbia (estimated 6,109) and remained stable in Oregon (estimated 3,443). Numbers in British Columbia were estimated at 6,109 and stable in 1989 (Loughlin et al., 1992; Merrick, Calkins, and McAllister, 1992; 55 *FR* 49208) Numbers have been stable or declining somewhat in California (estimated 1,764). Counts made in previous years suggest <1,000 animals occupy Washington waters, where there are no rookeries. Pup counts in the above areas suggest their status and trends are similar to the adult population.

Steller sea lions occur over the continental shelf throughout the Gulf of Alaska south to southern California (Loughlin, Rugh, and Fiscus, 1984; USDOC, NOAA, NMFS. 1988). In Alaska, rookeries are located throughout the Aleutian Islands, on the Pribilof Islands, Sandman Reefs, Shumagin Islands, Semidi Islands, Chirikof Island, Marmot Island, Barren Islands, Pye Islands (Graphic 3), and the eastern Gulf of Alaska. Rookeries farther south are located at five sites in British Columbia, at Rogue and Orford Reefs in Oregon, and at Año Nuevo Island, Sugarloaf/Cape Mendocino, and St. George Reef in California (USDOC, NOAA, NMFS, 1991d). Critical habitat has been designated by the NMFS in Shelikof Strait and two areas in the Aleutian Islands as well as areas surrounding all rookeries and major haulouts in Alaska and rookeries in Oregon and California (58 *FR* 45269).

In Alaska, sea lions occupy rookeries from May to late July. Postbreeding season movements between rookeries and haulouts often are extensive in the Gulf of Alaska, and California males may travel to sites as far north as southeast Alaska. Females generally return to the rookery of their birth to breed (Kajimura and Loughlin, 1988).

Incidental observations made during marine bird surveys (Agler et al., 1995) indicate several hundred individuals occupy lower Cook Inlet in summer; smaller numbers are present in winter. Sea lions feed primarily on pollock and capelin; some squid also are eaten.

(2) Guadalupe Fur Seal: The most current estimate of this species' population is 2,000 animals (Fleischer, 1987). Breeding occurs only on Isla de Guadalupe off Baja California, and individuals appear regularly in the California Channel Islands (Bonnell and Dailey, 1990). Arrival at the rookery begins in late May, and females probably nurse their pups for at least 8 months. Males begin to leave the rookery by late July.

c. Southern Sea Otter: A 1992 survey of the California sea otter population recorded 2,101 animals (USDOI, FWS, 1993). Otters range in central California from Point Año Nuevo south to Point Conception. Otters also have been translocated to San Nicolas Island off southern California. In California, sea otters inhabit shallow nearshore waters <18 m deep, rarely moving >2 km offshore (Riedman, 1987). Otters breed and pup throughout the year, but peak periods occur in most areas; pups remain with the female from 4 to 8 months. Sea otters in California feed almost entirely on macroinvertebrates (Bowlby, Troutman, and Jeffries, 1988; Estes, Jameson, and Johnson, 1981; Riedman and Estes, 1987).

d. Birds:

(1) Short-Tailed Albatross: The short-tailed albatross has staged a slow recovery since the 1950's (currently, 7% annual population-growth rate) to its current population of about 500 individuals (Hasegawa, 1992, personal comm.). Although of rare occurrence, apparently this species still occurs over much of its historic range in the North Pacific, including coastal areas from Alaska to Baja California (Hasegawa and DeGange, 1982).

(2) Peregrine Falcon: Based on 1991 surveys, the population of arctic peregrine falcons in Alaska is estimated to be 160 pairs; the American peregrine population is about 225 pairs, while in California 125 pairs are estimated (Ambrose, 1991, personal comm.).

Arctic peregrine falcons nest on the Seward Peninsula and north of the Brooks Range; American peregrines nest south of the Brooks Range. Peregrines usually are present in Alaska from about mid-April to mid-September. Egg laying begins in early May in interior Alaska and early June on the North Slope; the young fledge in late July and mid-August, respectively. These subspecies probably do not make significant use of the proposed Sale 149 area; occasional individuals may winter in the region. Peregrines that occur along the California coast probably are residents, although some winter movements may occur. Most major river mouths and estuaries in northern California are important foraging areas.

Limited data regarding migration routes suggests that peregrines from the North Slope and eastern interior Alaska generally follow the central flyway while those from the western interior follow the Pacific flyway.

Peregrines probably occur in the Gulf of Alaska/Cook Inlet area only irregularly during migration (USDOI, FWS, Peregrine Falcon Recovery Team, 1982).

Reclassification of the American peregrine currently is under study by the Fish and Wildlife Service (56 *FR* 26969); removal of the arctic peregrine recently has been proposed (58 *FR* 51035).

(3) Aleutian Canada Goose: Current breeding range of the Aleutian Canada goose includes several islands in the central and western Aleutians, and Kiliktagik and Anowik Islands in the Semidi Islands south of the Alaska Peninsula (USDOI, FWS, Aleutian Canada Goose Recovery Team, 1991; Anderson, 1993, personal comm.). Peak counts on the wintering areas (California, Oregon) suggest the current population is about 9,000 individuals (Dahl, 1993, personal comm.). Those wintering in northern coastal Oregon, estimated at 132 individuals (Lowe, 1993, personal comm.), breed in the Semidis (25+ pairs in 1990), while those staging or wintering in southern coastal Oregon and northern coastal California breed in the Aleutians. Several coastal islands in Oregon and California are used by wintering geese for roosting. The Aleutian Canada goose was reclassified from endangered to threatened status as of 1991 (55 *FR* 51106).

(4) __Steller's Eider__: Most of the world population of Steller's eiders (70,000-100,000) nest in northern Siberia. Approximately 2,000 nest in northwestern Alaska, primarily in the area south of Barrow (57 *FR* 19852); this represents a substantial contraction of their former breeding range in Alaska. Males depart the nesting areas in late June, while females with broods apparently remain in until late August or early September. Reproductive success generally is low with occasional good years, suggesting that productivity is dependent primarily on adult survival. Most of the population molts along the Alaskan coast from Nunivak Island to Izembek Lagoon and winters from the eastern Aleutian Islands to lower Cook Inlet. Dick (1977) and Forsell and Gould (1981) estimated from 1,000 to 2,000 wintered in the Kodiak Island area in the late 1970's. Recent Christmas count and other survey information suggest that an estimated 2,000 winter in the vicinity of Chiniak Bay alone.

(5) __Bald Eagle (WA, OR, CA)__: The breeding range of threatened/endangered bald eagle populations includes Washington, Oregon, and northern California. Surveys in 1989 recorded 366 active pairs in Washington, 165 in Oregon, and 83 in California; most of these were inland with only about 20 to 25 percent located along the Pacific coast (McAllister, 1989, personal comm., as cited in USDOI, MMS, 1992). The onset of breeding in these areas generally occurs from January to March. The greatest concentrations of nests in Washington occur on the Olympic Peninsula and lower Columbia River. Although some eagles that overwinter in coastal Washington are migrants from farther north, most are residents, and no large winter roosts are known to occur along the coast. In Canada, large numbers of eagles are present throughout the year on the Queen Charlotte Islands and Vancouver Island.

(6) __Brown Pelican__: In 1986, the population of brown pelicans nesting on Anacapa and Santa Barbara Islands in southern California was estimated to be 7,349 pairs (Harlow, personal comm., as cited in USDOI, MMS, 1987). Most pelicans nest on islands in the Gulf of California or off mainland Mexico.

The breeding season in California extends from March through early August. Postbreeding pelicans may occur from southwestern Mexico to British Columbia. They usually appear north of Point Conception by July. Important roost sites during the postbreeding period include the Long Beach breakwater, offshore rocks from Pismo Beach to Morro Bay, and Monterey Bay. Late summer/early fall concentrations also occur in southern Oregon and southern Washington coastal areas (Lowe, personal comm., as cited in Briggs et al., 1989). Most pelicans forage within 20 km of the coast (Briggs et al., 1987).

(7) __California Clapper Rail__: No information was received.

(8) __Light-Footed Clapper Rail__: An estimated 178 pairs of light-footed clapper rails bred in southern California in 1987; the estimate for northern Baja California was 240 pairs. Nesting occurs in 16 saltwater marshes within this range (Eddleman et al., 1988).

(9) __Western Snowy Plover__: Currently, 28 western snowy plover breeding sites are known from the Pacific coast—2 in southern Washington, 6 in Oregon, and 20 in coastal California. In Oregon, three sites contain 81 percent of that State's breeding population, and eight areas support 78 percent of the breeding population in California (58 *FR* 12864). Nesting typically occurs on unvegetated beach strands, sand spits, and other open areas influenced by wave action (Stenzel, Peaslee, and Page, 1981). Nesting occurs from mid-March to about mid-August, with an additional month required for the chicks to attain flight (Warriner et al., 1986). Adults and chicks usually leave the nest territory soon after the latter hatch. Snowy plovers forage in the sandy intertidal zone as well as in dry, sandy areas above this zone and along the edges of saltmarshes and ponds.

(10) __California Least Tern__: The estimated breeding population of least terns was over 1,800 pairs in 1991. The breeding season begins in late April when terns establish small colonies on sandy beaches or mud flats from Baja California to San Francisco Bay. Breeding is limited to about 25 colonies, primarily in southern California. Southward migration to Mexican wintering areas begins in August and most individuals have departed by late September (Garrett and Dunn, 1981).

(11) __Marbled Murrelet (WA, OR, CA)__: The FWS has determined the marbled murrelet to be a threatened species in Washington, Oregon, and California (57 *FR* 45328). The population estimated to breed in Washington is 5,000 birds (Speich, Wahl, and Manuwal, 1992). Fewer than this number inhabit coastal Oregon (Marshall, 1988; Varoujean and Williams, 1987), and recent estimates of <1,000 pairs

may represent this segment of the population more accurately (Nelson, 1992). In California, < 1,000 pairs are estimated to be present during the breeding season (Carter and Erickson, 1988; Marshall, 1988). An estimated 20,000 to 45,000 inhabit British Columbia (Rodway and COSEWIC, 1990). Coastal surveys in the U.S. indicate that recruitment of juvenile murrelets is very low, ranging from one to four fledglings observed for every 100 adults.

The FWS has proposed to designate critical habitat on Federal lands in all three states (59 *FR* 3811). Nesting aggregations are concentrated in the remaining patches of old-growth and old-growth/mature forests. Nesting occurs from mid-April to late September (Carter and Sealy, 1987). During the nesting season, murrelet concentrations are distributed at sea in a pattern roughly corresponding to old-growth and mature forests. Foraging takes place primarily in nearshore marine waters within 2 km of land. Large gaps in the breeding distribution occur between San Mateo County and Humboldt County in California and between the Olympic Peninsula in Washington and Tillamook County in Oregon. Seasonal changes in distribution and abundance of murrelets indicate that local migration takes place (56 *FR* 28362).

e. **Reptiles:**

(1) **Green Sea Turtle:** Sightings of green sea turtles have been recorded from Chile to British Columbia. Aside from a live beachcast individual in northern California, no sightings have been made off the California coast in recent years. They are observed in a limited portion of southern San Diego Bay. Egg laying probably occurs on west coast beaches of Mexico and south between May and September (Mager, 1984).

(2) **Leatherback Sea Turtle:** Aerial surveys off Washington and Oregon between April and September 1989 recorded 14 leatherbacks offshore in July and September (Brueggeman, 1989, personal comm., as cited in USDOI, MMS, 1992); individuals have been sighted as far north as Alaska (Mager, 1985). Nearly all sightings made during a 3-year survey off California occurred during summer and fall; individuals were distributed between 10 and 185 km offshore, with most over the continental slope (Dohl et al., 1983). Estimates from the early 1970's place the eastern Pacific nesting female population at 8,000 individuals (Pritchard, 1971).

(3) **Loggerhead Sea Turtle:** In the eastern Pacific, loggerheads nest on beaches of Central and South America. Southern California is accepted as this species' northern limit, because no sightings have been made farther north. A loggerhead was captured near Santa Cruz Island in 1978 (Guess, 1982).

(4) **Pacific Ridley Sea Turtle:** Major nesting beaches of the Pacific, or olive, ridley are found on the Pacific coast of Mexico. This species is an infrequent visitor to waters north of Mexico; they have been observed off Humboldt County, California, in December and off La Jolla, California, in August. Fewer than 80,000 adults were estimated to exist in 1983 (Mager, 1984).

6. **Terrestrial Mammals:** Approximately 38 species of terrestrial mammals occur in the lower Cook Inlet region, with about 20 of these species present on the Kodiak Archipelago. Ten mainland species that use the marine coastal environments to some degree include the river otter, brown bear, black bear, red fox, arctic fox, wolf, coyote, mink, wolverine, and moose. On the Kodiak Archipelago, the river otter, brown bear, and black-tailed deer use the coastal marine environment to a significant degree. Of these 10 species, only the river otter, brown bear, and Sitka black-tailed deer are expected to be affected by a potential oil spill associated with the proposal. A description of these species' use of coastal habitats in the lower Cook Inlet area follows.

a. **River otters** frequently occur in nearshore waters all along the coast of the proposed lease area, where they forage on small fish, clams, crustaceans, and other invertebrates. They also use the beaches and intertidal areas. Sculpins and rockfish were reported to be predominant prey items of river otters occurring along the coast of southeastern Alaska (Larsen, 1984).

b. **Brown bears** are found throughout most of the Kodiak Archipelago and on all of the mainland adjacent to the proposed lease area except the region south of Kachemak Bay. The estimated brown bear population of Kodiak and adjacent islands was 1,928 in 1989, excluding dependent juveniles (Smith and Trent, 1991). The estimated brown bear population for the Alaska Peninsula in 1989 was 5,679 (Sellers, Trent, and Miller, 1991). The brown bear population of Katmai National Park recently was estimated at between 1,500 to

2,000 bears and a total brown bear density along the coast of Katmai at 537 bears/1,000 km^2 (Sellers et al., 1993). Brown bears use the coastal areas from about April to November. During spring, bears rely heavily on coastal beaches, meadows, and shorelines while foraging on newly emergent plants, carrion, and intertidal infauna such as clams (see Spring Concentration Areas, Graphic 4). During the summer and early fall, brown bears congregate along coastal streams to feed on salmon and other spawning fish (see Bear Intensive Stream Utilization, Graphic 4). The salmon runs are especially important to the Kodiak, Alaska Peninsula, and McNeil River brown bears and are available from late June to mid-December on Kodiak Island (Barnes, 1990). Female brown bears on the Alaska Peninsula generally are most productive between 9 and 16 years old, and litters of three cubs are more common there compared to other areas; litters of four cubs are known to occur only on Kodiak Island and the Alaska Peninsula (Modafferi, 1984).

e. <u>Sitka black-tailed deer</u> are found on Kodiak, Afognak, and Raspberry Islands. The beaches and coastal areas are the primary winter range of this species (see Deer High Density Winter Range, Graphic 4). Deer concentrate on the outer capes along the coast during the winter, where they forage on kelp (Calkins and Curatolo, 1979). During severe winters, the beach habitats sometimes provide most of the available food of deer (Smith, as cited by Calkins, 1979).

C. **Social Systems:**

1. **Economy:** The population, employment, and infrastructure of the State of Alaska are concentrated in what is known as the "rail belt," which stretches from Seward to Fairbanks. Anchorage, the largest city in the State, with approximately half the State's population, is the focal point of economic activity in Alaska. Population and economic activity in the remainder of the State are focused in regional centers that are spread throughout Alaska. Fishing is a significant activity located primarily in coastal centers.

Historically, the economy of the State has depended on fishing and fish processing and timber and lumber processing. There also have been sporadic periods of mining, centered primarily on precious metals. The Government became a major factor with the advent of World War II and has remained a key employer in Alaska.

Starting in the 1950's, oil and gas have developed into a major economic force within the State. The total employment in Alaska more than doubled during the decade from 1965 to 1975. Employment and real income doubled again between 1975 and 1985. Total real income tripled, and per capita income was double that of the growth rates for the rest of the U.S. Alaska moved from being one of the poorer states to one of the richest. Most of this economic change was generated by the oil and gas industries on the Kenai Peninsula and the North Slope. Between 1986 and 1992, the economy slowed considerably because of the sudden decline in the price of oil in 1986 and declining oil production from wells in Cook Inlet and the North Slope.

Recreation and tourism have increased steadily during the last three decades. Since 1980, the increase in the number of tourists to Alaska has been approximately 5 percent annually. With diversification and the influx of new business and industries, a much larger support sector has emerged. These new jobs tended to reduce the seasonal fluctuations, providing a more stable, year-round economy (Munger, 1972). However, tourism still remains a largely summer-season activity.

In State waters, a major oil and gas reserve was discovered in 1957 and was developed during the 1960's and 1970's at Kenai Peninsula and Cook Inlet. Production, processing, and transmission facilities were developed within the region (UAA, Institute of Social and Economic Research [ISER], 1979).

Employment data in 1990 for the State, Anchorage, Kenai Peninsula Borough, Kodiak Island Borough, cities, and census-designated places in areas that are proximate to the Sale 149 area are provided in Table III.C.1-1. Tables III.C.1-2 and 1-3 provide the nonagricultural employment data by industry for 1980 and 1991 for the State of Alaska, Anchorage, Kenai Peninsula Borough, and Kodiak Island Borough.

Traditional economic analysis segments economic activity and employment into two sectors, basic and nonbasic. Basic economic activity results in an export of products and/or services from one area to another. Nonbasic economic activity and employment is a support sector that produces goods and services for local consumption.

Basic employment most significant in Alaska are in seven classes: (1) fishing; (2) fish processing; (3) logging; (4) wood-product processing; (5) petroleum- product processing; (6) tourism, hotels, and eating and drinking places; and (7) all other forms of primary manufacturing, agriculture production, etc. All of these are important components of the economy on the Kenai Peninsula and Kodiak Island proximate to the Sale 149 area. However, conventional categories used by data-collecting agencies are similar to but do not exactly reflect these categories. The best data available are provided in Tables III.C.1-1 and 1-3.

The nonbasic support sector, which primarily is involved in the sale of goods and services, is comprised of five classes:

(1) trade, which is involved with commerce activities, such as wholesale and retail outlets and stores;

(2) services, which include, for example, mechanics, repair personnel, cooks, food servers, barbers, tour-boat operators, or hunting guides;

(3) transportation, communication, and public utilities, which involve persons who work for telephone companies, gas and electrical utilities, trucking companies, bus lines, etc.;

Table III.C.1-1
Civilian Labor Force Employment, 1990

Community	Labor Force
State of Alaska	5,379
Municipality of Anchorage	111,242
Kenai Peninsula Borough	17,137
Anchor Point CDP[1]	268
Clam Gulch CDP	24
Cohoe CDP	190
Cooper Landing CDP	98
Crown Point CDP	31
English Bay CDP	30
Fox River CDP	121
Fritz Creek CDP	582
Halibut Cove CDP	86
Happy Valley CDP	61
Homer	1,654
Hope CDP	61
Jakolof Bay CDP	17
Kachemak	170
Kalifonsky CDP	96
Kasilof CDP	155
Kenai	2,738
Moose Pass CDP	23
Nikiski CDP	1,059
Nikolaevsk	86
Ninilchik CDP	146
Port Graham CDP	41
Primrose CDP	59
Ridgeway CDP	1,003
Salamatof CDP	274
Seldovia	97
Seward	1,138
Soldotna	1,596
Sterling CDP	1,617
Tyonek CDP	33
Kodiak Island Borough	6,178
Akhiok	26
Chiniak CDP	37
Karluk CDP	30
Kodiak	3,507
Kodiak Station CDP	344
Larsen Bay	36
Old Harbor	42
Ouzinkie	77
Port Lions	85
Womens Bay CDP	274
Southern Alaska Peninsula —— Selected Cities	
Chignik (Bay) City	68
Chignik Lagoon CDP	8
Chignik Lake CDP	28
Ivanof Bay CDP	13
Perryville CDP	19

Source: USDOC, Bureau of Census, 1992.

[1] CDP = Census Designated Place.

Table III.C.1-2
Nonagricultural Employment by Industry, 1980 and 1991, Kenai Peninsula and Kodiak Island

	Kenai Peninsula Borough		Kodiak Island Borough	
	1980	1991	1980	1991
Total	8,398	14,377	4,642	5,711
Mining	783	1,156	0	0
Construction	617	713	102	161
Manufacturing	1,662	2,066	1,824	2,091
Food and Related Products	926	1,284	1,544	1,961
Transportation Communication Utilities	689	1,006	352	320
Trade	1,353	2,708	611	931
Wholesale	261	379	35	41
Retail	1,092	2,329	576	890
Finance, Insurance, Real Estate	220	277	99	112
Services	1,109	2,807	562	955
Agriculture, Forest, Fish	44	*	*	*
Government	1,896	3,398	1,038	1,116
Federal	180	289	286	165
State	528	1,051	208	275
Local	1,189	2,058	545	677
Nonclass	25	*	*	*
Miscellaneous	-	-	-	-

Source: State of Alaska, Dept. of Labor, Research Analysis, Benchmark, 1991.

* Nondisclosable

Table III.C.1-3
Nonagricultural Employment by Industry, 1980 and 1991, Alaska and Anchorage

Industry	Alaska		Anchorage	
	1980	1991	1980	1991
Total Nonagriculture Wage and Salary	170,900	243,100	80,050	113,100
Goods Producing	-	40,500	-	12,300
Mining	6,700	11,800	2,650	3,900
Construction	10,600	10,500	5,450	5,800
Manufacturing	14,000	18,200	2,650	2,600
Durable Goods	-	3,400	-	500
Lumber and Wood Products	-	2,600	-	-
Nondurable Good	-	14,800	-	2,100
Seafood Processing	-	10,900	-	-
Pulp Mills	-	900	-	-
Food and Related Products	7,800	-	-	-
Lumber and Paper Products	3,500	-	-	-
All Other Manufacturing	2,700	-	-	-
Services Producing	-	202,600	-	100,800
Transportation	17,200	21,800	8,000	11,900
Trucking and Warehousing	2,000	2,800	1,100	1,700
Water Transportation	1,400	1,500	300	300
Air Transportation	5,200	7,000	3,000	4,400
Communications	-	3,500	-	2,200
All Other Transportation	8,500	-	3,600	-
Trade	29,400	46,900	17,050	26,000
Wholesale Trade	5,500	7,800	4,100	5,700
Retail Trade	23,800	39,100	12,900	20,400
General Merchandise and Apparel	4,300	6,200	1,750	3,200
Food Stores	3,700	7,000	1,650	3,300
Eating and Drinking Places	8,000	13,400	4,550	7,500
All Other Retail Trade	7,800	-	4,950	-
Finance, Insurance, and Real Estate	8,100	10,700	5,250	6,600
Services and Miscellaneous	30,200	51,800	17,050	28,900
Hotels and Lodging Places	-	5,500	-	2,400
Health Services	-	11,100	-	5,900
Government	54,800	71,400	21,950	27,400
Federal	17,700	18,900	9,550	10,600
State	15,400	21,200	5,000	7,900
Local	21,600	31,300	7,450	8,800

Source: State of Alaska, Dept. of Labor, Research Analysis, Benchmark, 1991.

(4) finance, insurance, and real estate, which include persons who work for such agencies as banks, credit unions, insurance agencies, and real estate agencies; and

(5) construction, which includes workers employed by construction companies, both residential and commercial.

The Government sector is comprised of four classes. Three classes are civilian employees with Federal, State, and local agencies; the fourth is military. Government employment in many areas in Alaska is a very significant portion of the total employment. Federal and State employment sometimes is considered basic employment, because it often is independent of the other classes and sectors of employment. Local government is secondary in nature and often is considered a part of the support sector. However, all forms of government employment are related to revenue or taxes, and government is shown as a separate sector of employment.

In 1980, the Cook Inlet and Shelikof Strait region had almost half of the State's total population (USDOC, Bureau of the Census, 1981). The majority of the State's transportation, industry, and government activities is focused in this region. Most northbound maritime traffic enters the ports in the region with material either for consumption or transshipment by rail, road, or air. This region has the bulk of the State's service and financial industry. Many Statewide businesses have their headquarters in this region, and most Federal and State Government agencies have regional offices in Anchorage. This region also houses the State's two largest military bases, Elmendorf Air Force Base and Fort Richardson; and it is the center for most oil and gas companies and associated support businesses, including those for North Slope operations and the Trans- Alaska Pipeline System (UAA, ISER, 1979, and Munger, 1972). Between 1980 and 1992, the Cook Inlet and Shelikof Strait region maintained its position with respect to the above characteristics as reflected by the employment data presented in Tables III.C.1-2 and 1-3.

Basic employment is the largest sector in Kodiak and Homer, while the support sector is largest in Kenai and Seward. Much of the employment in the Cook Inlet/Shelikof Strait region is seasonal. Seasonal employment usually peaks during the summer when fishing, logging, tourism, etc., are at their peak. Minimal employment usually occurs during the winter when weather prevents many forms of employment (e.g., construction, fishing, and logging).

One of the major industries in the region is commercial fishing and fish processing. (See Sec. III.C.2 for a description of the area's commercial fisheries.)

2. <u>Commercial Fisheries</u>: The lower Cook Inlet region commercial fisheries have harvested shellfish (crabs, shrimp, scallops, and clams), herring, salmon, and groundfish. In 1993, the estimated value of these fisheries to lower Cook Inlet fishermen was about $3 million (DeVito, 1993, personal comm.). Of this value, salmon yielded an ex-vessel value of just $1.14 million from a harvest of 1,109,856 salmon of all species (State of Alaska, ADF&G, 1993). In the State waters of the Central Regulatory Area (Fig. III.C.2-1), which includes but is not limited to lower Cook Inlet, 6.0 million pounds of groundfish were harvested in 1991, with an estimated ex-vessel value of $19 million (State of Alaska, ADF&G, 1992). Much larger totals were harvested from the federally managed areas of the Exclusive Economic Zone, which also includes portions of the lower Cook Inlet and Shelikof Strait. One or more of these commercial fisheries may operate during most of the year and over much of the proposed Sale 149 area; and commercial fisheries beyond the Sale 149 area also might be affected by this proposed action. Figure III.C.2-2 shows the Cook Inlet commercial-fishing seasons and the gear type used.

Commercial fishing in the Cook Inlet area is described qualitatively and quantitatively in great detail in a report prepared for MMS (Northern Economics, 1991). Most data in the document are for each year for the period 1981 through 1988 and are for the geographic area of the Gulf of Alaska and contiguous coastal lands. This document is incorporated by reference, and pertinent data are summarized as follows. Employment in domestic longline fisheries ranged from 2,495 in 1981 to 8,684 in 1988 (Northern Economics, 1991: 60). Harvest in the domestic crab-pot fishery ranged from a high in 1981 of 72 million pounds to a low of 13 million pounds in 1987; earnings were $85 and $28 million, respectively (Northern Economics, 1991:66). Average total crews in the gillnet fishery were 1,090 in 1981 and 1,334 in 1988, which were the high and low figures for that period (Northern Economics, 1991:70). The harvest in the domestic gillnet fishery for salmon in 1981 was 77 million pounds, and earnings were $63 million; in 1988, the harvest was 100 million pounds, and earnings were $189 million. The harvest for herring in 1981 was 6 million pounds, and earnings were $1.4 million; in 1988 the harvest was 3.6 million pounds, and earnings were $2.8 million (Northern Economics, 1991:72). Average total crew for the seine fishery

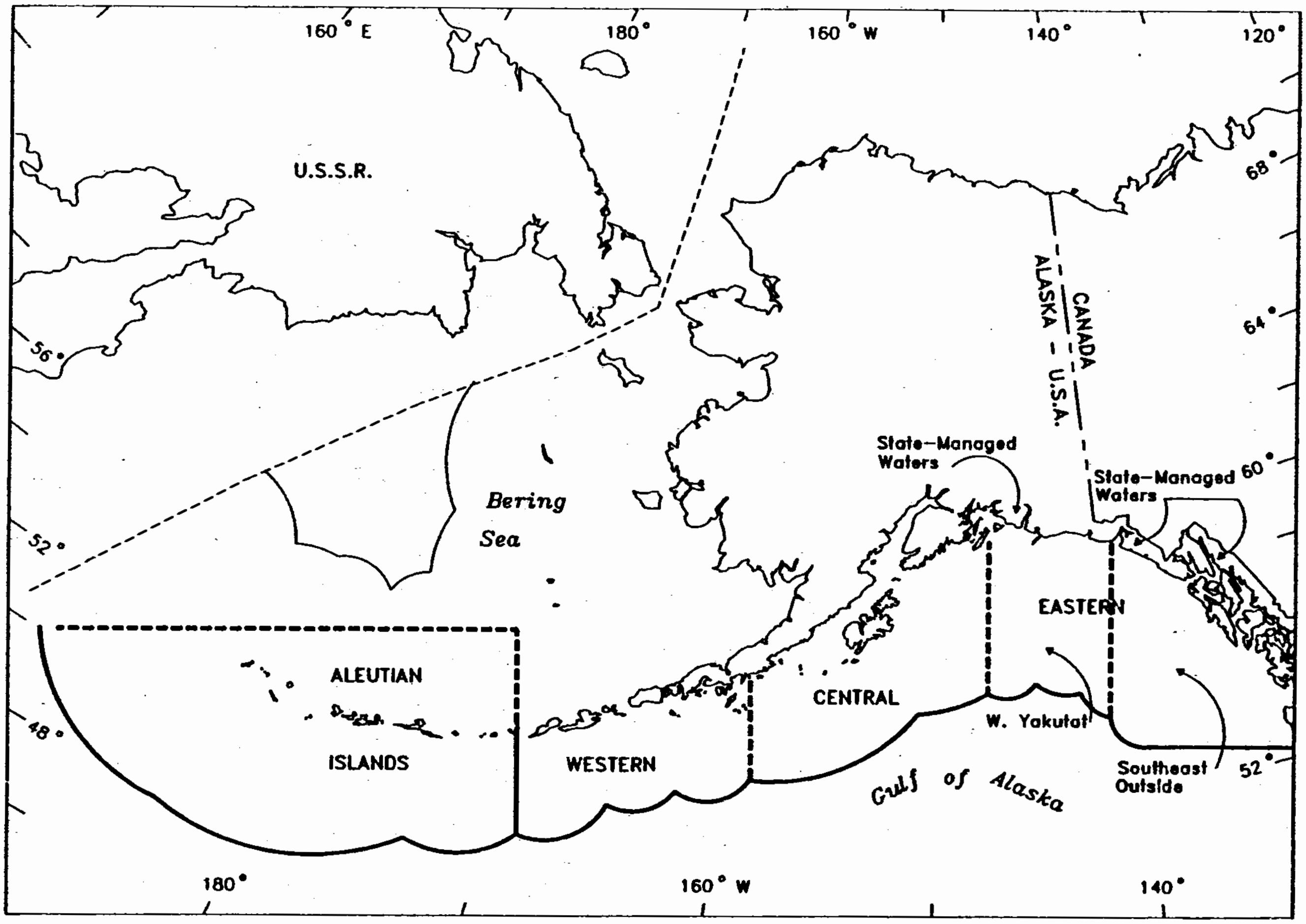


Figure III.C.2-1. Major Groundfish Regulatory Areas of the Bering Sea, Aleutian Islands, and Gulf of Alaska and Areas Managed Separately for Groundfish by the State of Alaska. All Other Alaskan Waters of the Territorial Sea (Inside 3 Miles) are Managed Concurrently with the Groundfish Fisheries Management Plans.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
SALMON												
Upper Cook Inlet												
chinook						Gill net						
sockeye						▨	Gillnet	▨				
coho								Gillnet	▨			
pink						▨	Gillnet	▨				
Lower Cook Inlet												
pink							Seine or Gillnet	▨				
sockeye						▨	Seine or Gillnet	▨				
chum							▨	Seine or Gillnet	▨			
HERRING												
sac roe				Seine	▨							
Upper Cook Inlet												
food and bait				Gillnet	▨							
Lower Cook Inlet												
sac roe				Gillnet	▨							
SHELLFISH												
Dungeness crab								Pot	▨			
Tanner crab	Pot	▨										
shrimp	▨	Trawl	▨			▨	▨	▨	Trawl	▨	▨	▨
shrimp	▨	Pot	▨			▨	▨	▨	Pot	▨	▨	▨
clam	▨	▨	▨	▨	▨	Shovel	▨	▨	▨	▨	▨	▨
GROUNDFISH												
cod	▨	Pot or Longline	▨	▨						▨	Pot or Longline	▨
rockfish	▨	▨	▨	▨	▨	Jig	▨	▨	▨	▨	▨	▨

Source: ADF&G, 1992

Figure III.C.2-2. Cook Inlet Commercial Fishing Seasons and Gear.

was 1,064 in 1981 and 1,106 in 1988, which was the peak for the 8-year period; the smallest total crew for the period was 952 in 1983 (Northern Economics, 1991:74).

In Northern Economics (1991), profiles are presented describing the socioeconomic, infrastructure, and industry characteristics of seven of the more important commercial-fishing centers of the Gulf of Alaska: Cordova, Homer, Kenai, King Cove, Kodiak, Seward, Unalaska/Dutch Harbor, and Yakutat. The local economy; population; employment; income; public fiscal characteristics; transportation facilities; marine services; utilities; housing; land availability; and the harvesting, processing, and support sectors of commercial fishing are described for each community.

a. The Shellfish Fishery: Lower Cook Inlet now supports only commercial shellfish fisheries for clams, mussels, and brown king and tanner crabs. More extensive commercial fisheries for king and dungeness crabs and other shellfish should occur again in future years as the stocks increase. There now are very limited recreational food fisheries for crab and shrimp.

Crabs are caught using baited pots that usually are deployed in strings (lines) in large numbers. These pots have rebar metal frames with netting over them and with one or more biodegradable net panels to allow the catch to escape in the event the pot is lost. When fishing, pots may become lost when their buoy or other lines part or the buoys are sunk. This may be caused by a number of factors, e.g., storms, other vessel traffic, and/or marine mammal predation. Specialized vessels are used in the lower Cook Inlet crab fisheries, although vessels used in other fisheries may be seasonally converted for use in these now sometimes short-season commercial crab fisheries.

Management: The State of Alaska, ADF&G, manages the crab fisheries of lower Cook Inlet and other Federal offshore areas in cooperation with NMFS and the North Pacific Fisheries Management Council (NPFMC). The State of Alaska is able to regulate the crab fisheries in Federal waters by providing that crab harvests landed in Alaskan ports must be taken in compliance with State management regulations. To ensure conservation of crab resources, seasons are established by ADF&G and, for some species, harvest quotas (limits) are set, with coordination and in cooperation with the Federal fisheries agencies.

Brown king and tanner crabs may be harvested within portions of the proposed sale area with only late spring-early summer season closures now in effect. Diminished numbers of red king crab, however, have required some fishing closures in lower Cook Inlet and Shelikof Strait areas and parts of the Gulf of Alaska, while dungeness crab fishing is somewhat limited by market conditions and harvests from other Pacific Coast areas (Washington, Oregon, and California). The dungeness crab inhabits relatively shallow waters and sheltered bays and are fished using smaller, different-sized and -shaped pots.

Pandalidid shrimp are harvested using trawls or pots, with trawls predominant. Shrimp trawls are large net bags towed behind a vessel. The bags enclose the shrimp and then are winched aboard the fishing vessel and the catch removed. Table III.C.2-1 shows the pot-shrimp harvest from Cook Inlet during the years 1986 to 1990. There was no commercial fishery for shrimp in lower Cook Inlet and Shelikof Strait in 1990 to 1991 due to low stocks (State of Alaska, ADF&G, 1992).

Scallops are harvested commercially during some years, but these efforts have been limited until recently. Scallops are harvested using specialized bottom-trawl gear; however, the vessels also are used in other commercial-fishing operations. Because scallop dredges injure softshell crab, some areas off Kodiak are closed to scallop fishing during all or part of the year. In 1990, a total of 898,277 lb of scallops were harvested from waters off Kodiak Island, with an ex-vessel value of about $3.2 million (State of Alaska, ADF&G, 1991).

b. The Herring Fishery: Pacific herring are harvested annually in lower Cook Inlet and Shelikof Strait during the months of April and May. The fish are used mainly for their roe and sac-roe-on-kelp marketed in Pacific Rim countries and for bait used in other domestic fisheries. Some carcasses are processed into fish meal after the sac roe is removed. The fish itself is purchased by the ton, while roe-on-kelp is purchased by the pound. Herring are fished using purse seines and gillnets. In 1991, the Kodiak herring fisheries harvested 2,432 tons, with an average value to individual fishermen of about $55,000 (State of Alaska, ADF&G, 1992). Table III.C.2-2 is a summary of the Kodiak herring sac-roe fishery.

Table III.C.2-1
Pot Shrimp Catch and Effort in Outer Cook Inlet (Area G)[1], Cook Inlet Management Area, 1986 to 1990

Season	Number of Vessels	Catch (lb)
1986	4	2,967
1987	9	2,458
1988	7	3,445
1989[2]	8	20,500[3]
1990	5	8,853

[1] See Figure III.C.2-3.

[2] Season was closed from April 30 through July 7 because of the *Exxon Valdez* oil spill.

[3] Includes 600 lb deadloss, oiled, pot shrimp.

Table III.C.2-2
Kodiak Herring Sac-Roe Fishery Summary 1987 to 1991

Year	Season Length Daye	Guideline Harvest Level (tons)	Total Harvest (tons)	Average Amount Earned ($)	
				Seine	Gillnet
1987	61	1,640	2,146	54,872	8,945
1988	59	2,065	2,171	51,350	14,837
1989	76	2,415	2,249	34,749	7,537
1990	75	2,375	2,347	51,724	9,652
1991	83	2,510	2,432	45,077	9,762
5-Year Average	71	2,201	2,269	47,554	10,147

Source: State of Alaska, ADF&G, 1992.

c. **The Salmon Fishery:** In lower Cook Inlet and Shelikof Strait and off Kodiak, all five species of Pacific salmon are harvested commercially (and also for subsistence use and sport). Those in Shelikof Strait and near Kodiak Island are closely equivalent to those in the lower Cook Inlet, with slightly different fishing seasons and periods. Lower Cook Inlet and Kodiak salmon fisheries use purse seines, drift gillnets, set gillnets and, in small numbers, beach seines (Fig. III.C.2-2). The regional salmon fisheries commence in early May and continue well into September each year.

Purse seines are long nets played into the water from the vessel as it travels in a large circle. A dory is positioned at the end of the net and, when the circle is nearly complete, the end is brought up to the vessel. The net balloons out to encircle a school of salmon, after which the net is pulled closed (pursed) at the bottom, trapping the fish. The seine and its catch are then hoisted aboard the vessel. Purse seines are most efficient in catching pink, chum, and sockeye salmon—species that congregate in large schools.

Drift gillnets are deployed from the fishing vessel and fish at some depth but well off the bottom, held in position by lead lines and floats. They may drift with the tide or be maneuvered by the fishing vessel. The salmon are enmeshed by their gills as they attempt to pass through the net. After a period of time, the net is reeled aboard and the salmon removed. Set nets, as named, are fixed gillnets that usually are fished near- shore and also enmesh migrating salmon. The net may then be beached or a small skiff used to remove the catch.

Beach seines have limited use in the lower Cook Inlet and Shelikof Strait region. These nets are deployed from shore, and a boat is used to attempt to encircle salmon, after which the seine is beached.

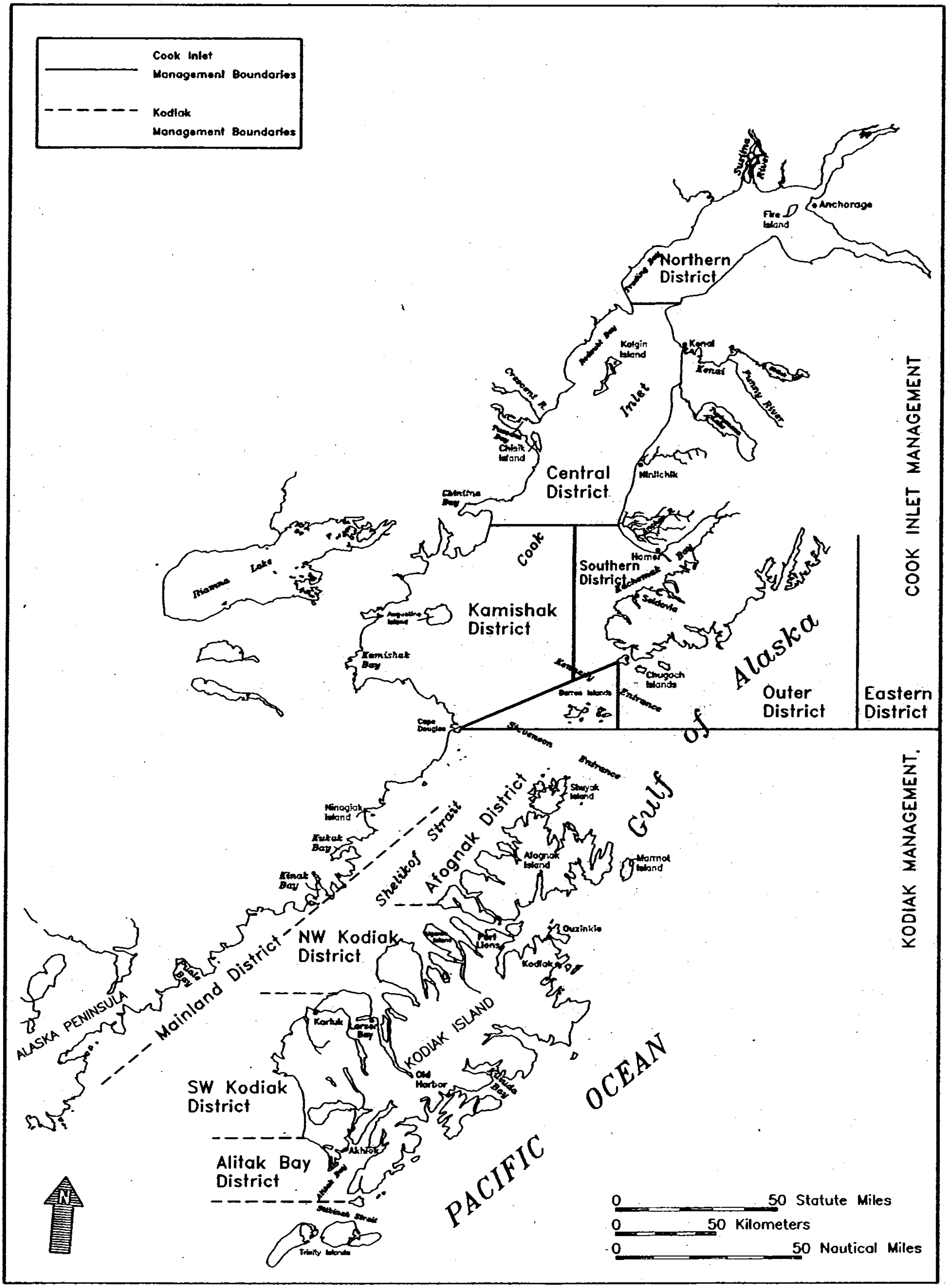
Lower Cook Inlet and Shelikof Strait region salmon are managed by the ADF&G and the Alaska Board of Fisheries, an appointed body. The seasons are set and the salmon fisheries are managed intensively for conservation. Salmon fishing districts, seasons, and the 1992 harvest are shown in Figure III.C.2-3 and Table III.C.2-3 (State of Alaska, ADF&G, 1992). Within a fishing season, there also are closed periods to allow for adequate spawning escapements, usually over weekends. Additionally, when spawning escapement numbers are low, ADF&G has the authority to impose emergency closures and other management actions to increase the number of salmon reaching the spawning grounds. Seasons and management regulations are reviewed periodically and published annually by the ADF&G.

d. **The Groundfish Fishery:** There are trawl; pot; longline; and small, sunken gillnet fisheries for a number of finfish species in the lower Cook Inlet and Shelikof Strait region that are loosely grouped as groundfish (or the marketing term, whitefish) due to their common deep habitat. Pollock, sole, flounder, turbot, and cod also are generalized names for the species within this group. Groundfish are harvested over extensive areas of lower Cook Inlet and Shelikof Strait during most of the year. There is a large trawl fishery for walleye pollock in much of Shelikof Strait in late spring, when large spawning populations congregate there.

The trawls used to catch groundfish are similar in construction to those used in the shrimp fishery; however, they are much larger, and are fished differently. Bottom trawls employ heavy panels (doors) and chains to maintain depth and position during trawling. The usual vessel for these trawl fisheries is the stern trawler, where the trawl net is deployed from the stern of the vessel and where tows may cover many miles over periods of several hours, sometimes 24 hours per day. The larger trawl vessels have onboard processing capability and may remain fishing for 2 to 3 months before returning to port.

The lower Cook Inlet and Shelikof Strait longline fishery primarily is for sablefish (black cod), Pacific cod, and the Pacific halibut. Longlines have a large number of leaders (ganglions) with baited hooks and are strung over long distances along the ocean bottom. The lines are anchored and buoyed and allowed to fish for several hours before retrieval. In the case of halibut where the entire season is now only for 24 hours twice yearly (early summer and early fall), the lines must be set and pulled during these 24-hour periods. There is an increasing number of fishermen who now use small pots to harvest sablefish and cod; and there has been some effort directed toward the use of sunken gillnets to harvest some groundfish.

To manage the groundfish fisheries, NMFS, the NPFMC, and the International Pacific Halibut Commission establish for each groundfish species seasons and harvest quotas called the Total Allowable Catch. Because the commercial-fishing effort cannot completely discriminate, some prohibited species also are caught, e.g., halibut



Source: ADF&G, 1992

Figure III.C.2-3. Salmon Management Areas of the Lower Cook Inlet and Shelikof Strait.

Table III.C.2-3
Lower Cook Inlet/Shelikof Strait Salmon Fishing Districts, Seasons, and the 1992 Harvest

District	Pink	Chum	Coho	Sockeye	Chinook
Southern	417,201	1,885	1,277	106,793	1,852
Kamishak	2,594	20,051	1,488	68,847	39
Outer	146	181	1	572	0
Eastern	60,007	86	1,608	432	0
Afognak	1,101,045	43,727	46,115	179,961	3,030
Northwest Kodiak	1,037,748	225,658	95,322	1,017,102	8,473
Southwest Kodiak	357,171	59,557	13,067	1,169,754	6,308
Mainland	188,752	113,803	31,755	630,073	2,841
Alitak Bay	58,207	113,803	24,547	523,661	1,049
Totals	3,222,691	578,751	215,180	3,697,195	23,592

Source: State of Alaska, ADF&G, 1992.

Table III.C.2-4
1991 Commercial Halibut Catch for Regulatory Areas 3A and 3B (Southcentral Alaska and Peninsula Ports)

Port	Catch (1,000 lb)
Cordova	1,385
Seward	3,283
Homer	5,456
Kenai	871
Kodiak	11,285
Chignik, King Cove, and Sand Point	4,352
Central Alaska	3,488
Total	30,129

Source: International Pacific Halibut Commission, 1990.

taken in the pollock-trawl fishery. This bycatch must be released; in some fisheries, bycatch becomes a limiting factor in length of the fishing season, because a season is closed when the bycatch limit is reached.

Figure III.C.2-4 shows the halibut regulatory areas, and Table III.C.2-4 shows the 1991 commercial halibut catch in thousands of pounds for areas 3A and 3B. Table III.C.2-5 shows recent-year lower Cook Inlet and Shelikof Strait commercial groundfish harvests (including halibut); however, portions of these harvests also are taken from the Gulf of Alaska.

e. __Fishermen's Contingency Fund__: Commercial-fishing gear sometimes is damaged, destroyed, or lost as a result of oil and gas operations on the OCS. In 1978, legislation was enacted to compensate fishermen for actual and consequential damages, including lost profits caused by oil and gas exploration, development, or production on the OCS. The regulations (50 CFR Part 296) establish procedures for administering the fund and for filing, processing, reviewing, adjudicating, and paying claims.

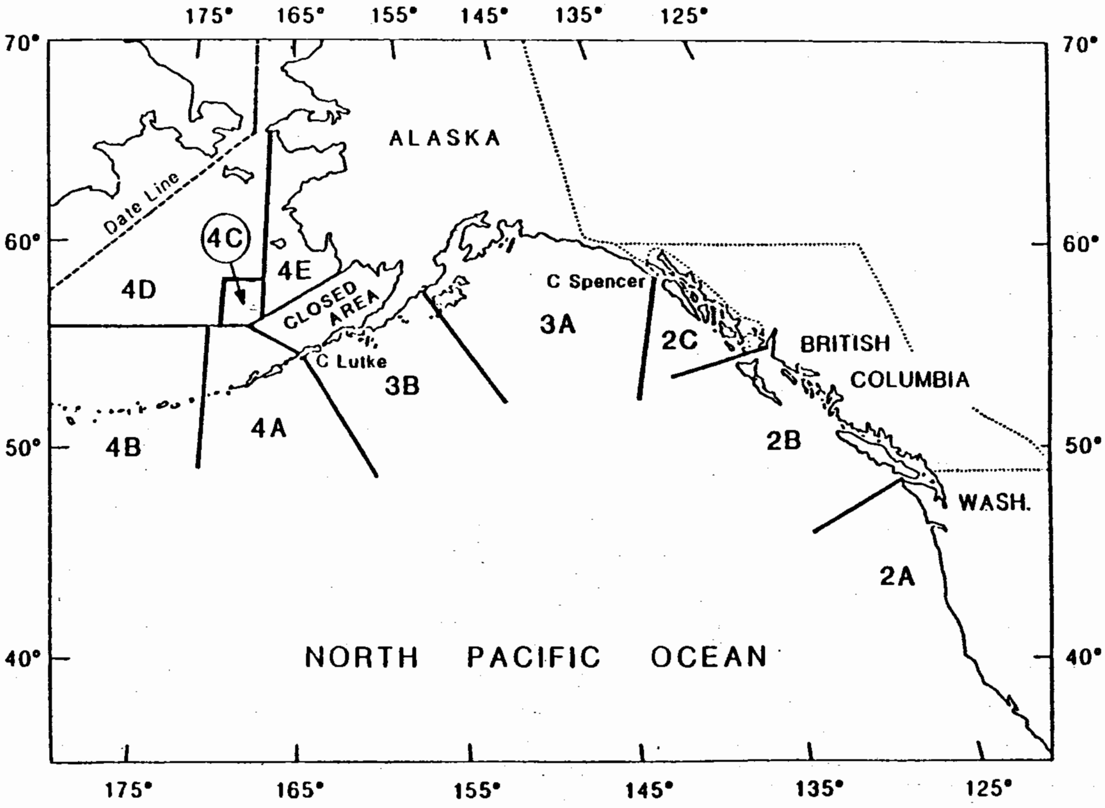
Individual Fishing Quota System: The United States Secretary of Commerce has recently approved the Individual Fishing Quota (IFQ) system for fixed-gear fisheries for halibut and sablefish in the North Pacific. The system went into effect in spring 1993, and actual operations will begin January 1, 1995, assuming Federal funding. Until 1995, the existing fisheries-management regime will be in effect. The purpose of the IFQ system is to end, equitably and fairly, the current fishing derbies, i.e., short, intensive openings for these two species; diminish pressure on the halibut and sablefish; and allocate fishing privileges to those who have invested in the fisheries and who show a recent dependence on the resources. At present, the large number of boats coupled with short openings has resulted in an often dangerous fishery that is difficult to manage.

The regulations for specific allocation of individual quota shares still are being prepared, which is the reason why the system will not be in place until 1995. Apparently, shares in these fisheries may be bought and sold freely.

3. __Subsistence-Harvest Patterns:__ Table III.C.3-1 shows the years that subsistence-harvest inventories were published for cities and selected Census Designated Place- (CDP-) named areas within that part of Alaska that potentially could be affected by Sale 149. These inventories generally were based on household sample surveys of annual subsistence harvests and contained information on dressed weights of wild foods produced by resource type or species. Other settlements in Alaska also might be affected by the lease sale, but the communities and places shown are meant to reasonably represent the area that may be potentially affected. The communities are organized among the following geographic areas: upper Cook Inlet, Central Kenai Peninsula, southern Kenai Peninsula, Kodiak Island, and upper Alaska Peninsula. The number of households enumerated in the 1990 U.S. Census of population is shown to illustrate the size of the respective communities.

a. __Characteristics of Harvest Activities:__ Table III.C.3-2 shows some characteristics of community subsistence harvests within the area potentially that may be affected by the lease sale. These characteristics include total per capita harvest in pounds of edible wild food and the percentage of households that used, harvested, received, and gave away subsistence resources. This subsistence-harvest information is only indicative of relative patterns because it covers only 1 year of activity. Specific characteristics of subsistence-harvest activities by community can be found in Schroeder et al., 1987; Reed, 1985; Wolfe and Ellanna, 1983; Fall, Foster, and Stanek, 1984; Morris, 1987; and Stanek, 1985.

Subsistence harvests, measured in useable pounds per person per year, by these data range from <40 lb in Kenai to >800 lb in Karluk. By geographic area, harvest products among the upper Cook Inlet and Kenai Peninsula Alaskan Native communities of Tyonek, Nanwalek (formerly English Bay), and Port Graham ranged from 227 lb in Port Graham to 289 lb in Nanwalek, with an average for the three communities of about 260 lb per capita. Useable harvest products among the other Kenai Peninsula communities (Seldovia, Homer, Kenai, and Ninilchik) ranged from 38 lb in Kenai to 94 lb in Homer, with an annual average of 67 lb per capita. On Kodiak Island, the nonroad-connected communities (Akhiok, Karluk, Larsen Bay, Old Harbor, Ouzinkie, and Port Lions) showed per capita harvests ranging from 280 lb in Port Lions to 863 lb in Karluk, with an average for the communities of 488 lb per capita. Elsewhere on Kodiak Island (Kodiak city, Chiniak, and the Kodiak Coast Guard Station), the harvests ranged from 147 lb in Kodiak to 217 lb in Chiniak, with an average of 177 lb for the three sites. The Chignik communities (Chignik, Chignik Lagoon, Chignik Lake, Ivanof Bay, and Perryville) had useable harvests ranging from 188 lb in Chignik to 456 lb in Ivanof Bay, with an average of 307 lb per capita.



Area 2A – All waters off the coast of California, Oregon and Washington
Area 2B – All waters off the coast of British Columbia
Area 2C – All waters off the coast of Alaska, south and east of Cape Spencer
Area 3A – All waters between Cape Spencer and Cape Trinity, Kodiak Island
Area 3B – All waters between Cape Trinity and a line extending southeast from Cape Lutke, Unimak Island
Area 4A – All waters west of Area 3B and of the Bering Sea closed area, south of 56°20' N. and east of 172°00' W.
Area 4B – All waters west of Area 4A and south of 56°20' N.
Area 4C – All waters in the Bering Sea north of Area 4A and northwest of a line running from Cape Newenham to a point at latitude 56°20' N., longitude 168°30' W., which are east of longitude 171°00' W., south of latitude 171°00' W., south of latitude 58°00' N., and west of longitude 168°00' W.
Area 4D – All waters in the Bering Sea north of Areas 4A, 4B, and 4C, and west of longitude 168°00' W.
Area 4E – All waters in the Bering Sea north of the closed area, east of Area 4C and 4D, and south of 65°34' N.

Source: International Pacific Halibut Commission, 1989

Figure III.C.2-4. Regulatory Areas for the 1990 Commercial Halibut Fishery.

Table III.C.2-5
Summary of Groundfish Harvest from Cook Inlet (CI), Prince William Sound (PWS), and State Waters of the Central Gulf of Alaska (CG) Located Adjacent to Cook Inlet and Prince William Sound

Area	Vessesls	Deliveries to Processors	Rockfish	Sablefish	Pacific Cod	Flatfish	Other	Ling Cod	Total
1987 Harvest									
CI	178	731	21,541	2,359	870,530	135,059	56,472	103	1,086,064
CG	117	312	169,147	36,797	790,633	887	5,138	25,522	1,028,124
PWS	100	207	90,061	184,581	415,483	27,113	8,117	594	725,949
1987	324	1,250	280,749	223,737	2,076,646	163,059	69,727	26,219	2,840,137
Average. Price/lb			0.31	0.64	0.24	0.28	0.25	0.45	
Value[1]			$87.6	$143.2	$498.4	$45.4	$17.1	$11.8	$803.5
1988 Harvest									
CI	67	178	7,154	74,337	215,586	220	275	127	297,699
CG	71	191	200,349	89,156	306,952	2,368	2,467	25,176	626,468
PWS	79	265	109,611	211,769	319,202	15,287	13,655	1,338	670,862
1988	171	634	317,114	375,262	841,740	17,875	16,397	26,641	1,595,029
Average. Price/lb			0.33	0.99	0.24	0.35	0.28	0.34	
Value[1]			$103.6	$371.5	$202.0	$6.2	$4.7	$9.1	$697.1
1989 Harvest									
CI	11	20	1,736	5,400	8,363	11	2,620	0	18,130
CG	25	56	50.089	3,739	30,789	0	389	7,026	92,032
PWS	39	132	91,508	180,903	65,698	0	2,113	1,280	341,502
1989	60	208	143,333	190,042	104,850	11	5,122	8,306	451,664
Average. Price/lb			0.41	0.89	0.21	0.10	0.16	0.36	
Value[1]			$58.1	$169.1	$22.0	$0.0	$0.8	$3.0	$253.0
1990 Harvest									
CI	88	302	134,853	24,664	387,779	5,002	10,593	394	563,285
CG	59	80	46,974	11,589	71,847	13	548	5,698	136,669
PWS	110	416	355,284	185,670	1,069,904	67,971	1,085	7,906	1,686,920
1990	211	798	537,111	221,923	1,528,630	72,986	12,226	13,998	2,386,874
Average. Price/lb			0.38	0.69	0.24	0.22	0.12	0.36	
Value[1]			$202.2	$153.1	$366.9	$16.3	$1.4	$5.0	$745.0
1991 Harvest									
CI	103	464	31,695	31,952	2,010,675	1,450	1,612	0	2,077,384
CG	113	262	224,592	72,155	913,019	175	1,238	65,256	1,276,435
PWS	141	403	125,467	293,814	2,201,304	2,917	1,104	19,357	2,643,963
1991	272	1,129	381,754	397,921	5,124,998	4,542	3,954	84,613	5,997,782
Average. Price/lb			0.28	0.91	0.28	0.23	0.46	0.37	
Value[1]			$106.9	$362.1	$1,435.0	$1.0	$1.8	$31.3	$1,938.

Source: State of Alaska, ADF&G, 1992.

[1] Values are in thousands of dollars.

Table III.C.3-1
Available Subsistence-Harvest Inventories

Area/Community	1990 Households	Harvest Inventory Years		
Upper Cook Inlet:				
Tyonek CDP	55	1983		
Central Kenai Peninsula				
Kenai city	2,329	1982		
Soldotna city	1,284		None	
Clam Gulch CDP	129		None	
Cohoe CDP	187		None	
Kalifonsky CDP	99		None	
Kasilof CDP	125		None	
Nikiski CDP	888		None	
Ridgeway CDP	686		None	
Salamatof CDP	264		None	
Sterling CDP	1,283		None	
Southern Kenai Peninsula				
Homer city	1,411	1982		
Kachemak city	140		None	
Seldovia city	129	1982		
Anchor Point CDP	314		None	
English Bay CDP (Nanwalek)	42	1981	1987	1989
Fox River CDP	67		None	
Fritz Creek CDP	491		None	
Halibut Cove CDP	23		None	
Happy Valley CDP	118		None	
Nikolaevsk CDP	80		None	
Ninilchik CDP	185	1982		
Port Graham CDP	60	1981	1987	1989
Kodiak Island				
Akhiok city	19	1982	1986	1989
Kodiak city	2,051	1982		
Larsen Bay city	44	1982	1986	1989
Old Harbor city	87	1982	1986	1989
Ouzinkie city	68	1982	1986	1989
Port Lions city	73	1982	1986	1989
Chiniak CDP	23	1982		
Karluk CDP	18	1982	1986	1989
Kodiak Station CDP	414	1982		
Women's Bay CDP	220		None	
Southern Alaska Peninsula				
Chignik city	46	1984	1989	
Chignik Lagoon CDP	17	1984	1989	
Chignik Lake CDP	34	1984	1989	
Ivanof Bay CDP	9	1984	1989	
Perryville CDP	31	1984	1989	

Source: Compiled by USDOI, MMS, Alaska OCS Region, 1992.

These data indicate that very large amounts of subsistence foods are harvested in each of these geographic areas. These subsistence foods include salmon, other nonsalmon fish, big game, small game and furbearers, marine mammals, birds and eggs, marine invertebrates, and plants and berries. The harvest and use of these foods represent activities having significant social and cultural meaning as well as economic importance, especially within predominantly Alaskan Native communities. Extensive sharing is commonplace, as suggested on Table III.C.3-2, by the high percentage of households in these communities that receive and give away subsistence resources.

Table III.C.3-3 shows, for 14 communities within the potential-effects area, the relative use of subsistence foods as represented by the percentage of consumable resources used within selected resource categories. (Again, this subsistence-harvest information is only indicative of relative patterns, because it covers only 1 year of activity.) This shows the relative importance of salmon for all communities, ranging from 39 percent of total consumable resources in Nanwalek to more than 70 percent in Tyonek and Chignik. Nonsalmon fish are heavily represented in Nanwalek (37% of total consumable resources) and Port Graham (34%), with relatively less use elsewhere. Big game is used extensively within the area that may be potentially affected by the lease sale, ranging from more than 10 to 40 percent of total consumable resources, although this is not the case in Nanwalek, Port Graham, or Chignik. The highest use of big game is found among the other Chignik communities, several Kodiak Island communities, and in Tyonek. Marine mammals are shown to be highly used in Old Harbor (25% of total consumable resources) and elsewhere ranging from 1 to 8 percent of total resources. Birds and eggs represent a relatively small proportion (1-2%) of total consumable resources. Marine invertebrates represent a considerably larger proportion of total consumable resources, ranging from 1 percent (Chignik Lake) to 12 percent (Larsen Bay) of total consumable resources.

b. Annual Round of Harvest Activities: Figure III.C.3-1 gives an example of seasonal harvest activities by showing the annual round of harvest activities for each of the six nonroad-connected communities on Kodiak Island. Illustrations of the annual round of harvest activities for the other communities in the area potentially affected by the lease sale are contained in Appendix H. The figures here and in Appendix H indicate the time of year, in units of quarter months, when some harvesting of a particular resource occurs. The figures indicate reported presence or absence of harvest during a particular quarter month; they do not show intensity of effort.

c. Geography of Harvest Activities: Figures III.C.3-2 through III.C.3-7 show the geography of harvest activities for the communities in the potentially affected area. Figures III.C.3-2a and b depict the inland and coastal resource harvest area for Tyonek in upper Cook Inlet during the period 1978 to 1984, along with the clusters of fish camps and setnet sites located from the community south to Granite Point (Fall, Foster, and Stanek, 1984). A composite resource-harvest area for the communities of Nanwalek and Port Graham is shown on Figure III.C.3-3. Residents from both communities use this area, although the English Bay and Port Graham Rivers are used primarily by residents of the respective communities (Stanek, 1985). Similar composite mapping is shown on Figure III.C.3-4 for each of the six nonroad-connected communities on Kodiak Island. The intensity of use of resource-harvest areas (shown on Fig. III.C.3-5) by type of activity for households among the Kodiak road-connected population in 1982 to 1983 is shown on Table III.C.3-4. Figure III.C.3-6 shows the composite resource-harvest areas known to be used in the period 1962 to 1982 by residents of Chignik and Chignik Lagoon, whereas Figure III.C.3-7 shows the composite resource-harvest areas known to be used in the period 1962 to 1984 by residents of Chignik Lake, Ivanof Bay, and Perryville.

d. Effects of the *Exxon Valdez* Oil Spill: The *Exxon Valdez* oil spill (EVOS) of March 1989 fouled the waters and beaches used for subsistence purposes by 15 predominantly Alutiiq (Alaskan Native) communities. This discussion of changes in subsistence harvests following the EVOS focuses on these communities.

With the exception of Chenega Bay and Tatitlek, located in Prince William Sound, 13 of these communities are located within the potential-effects area, including Nanwalek and Port Graham in lower Cook Inlet and the communities located on Kodiak Island and in the Chigniks on the upper Alaska Peninsula. In January to April of 1990, interviews of community residents were conducted by staff of the Subsistence Division, Alaska Department of Fish and Game, to determine changes in subsistence harvests and use that may have resulted from the oil spill (Fall, 1991; 1992). Results of these surveys are summarized on Tables III.C.3-5 and 6. Followup work was carried out in April and May of 1991 in Nanwalek, Port Graham, Ouzinkie, Larsen Bay, and Karluk.

Table III.C.3-2
Some Characteristics of Subsistence Harvests

			Percent of Households That			
	Year	Per Capita Harvest in Pounds	Used Resources	Harvested Resoures	Received Resources	Give Away Resources
Upper Cook Inlet:						
Tyonek	1983	260	NA	93	91	60
Kenai Peninsula:						
Nanwalek	1987	289	97	94	94	94
Port Graham	1987	227	100	100	98	82
Seldovia	1982	51	NA	94	NA	NA
Homer	1982	94	NA	86	NA	NA
Kenai	1982	38	NA	81	NA	NA
Ninilchik	1982	86	NA	92	NA	NA
Kodiak Island:						
Anhiok	1982	520	100	100	86	76
Karluk	1982	863	100	90	100	90
Larsen Bay	1982	404	100	94	97	88
Old Harbor	1982	491	100	100	82	78
Quzinkie	1982	369	100	97	91	84
Port Lions	1982	280	100	95	84	76
Kodiak	1982	147	100	90	90	79
Chiniak	1982	217	100	100	94	88
Kodiak Station	1982	168	71	71	33	26
Alaska Peninsula:						
Chingik	1984	188	100	84	95	79
Chingnik Lagoon	1984	220	100	88	82	71
Chignik Lake	1984	279	100	100	96	83
Ivanof Bay	1984	456	100	100	100	83
Perryville	1984	391	100	100	100	100

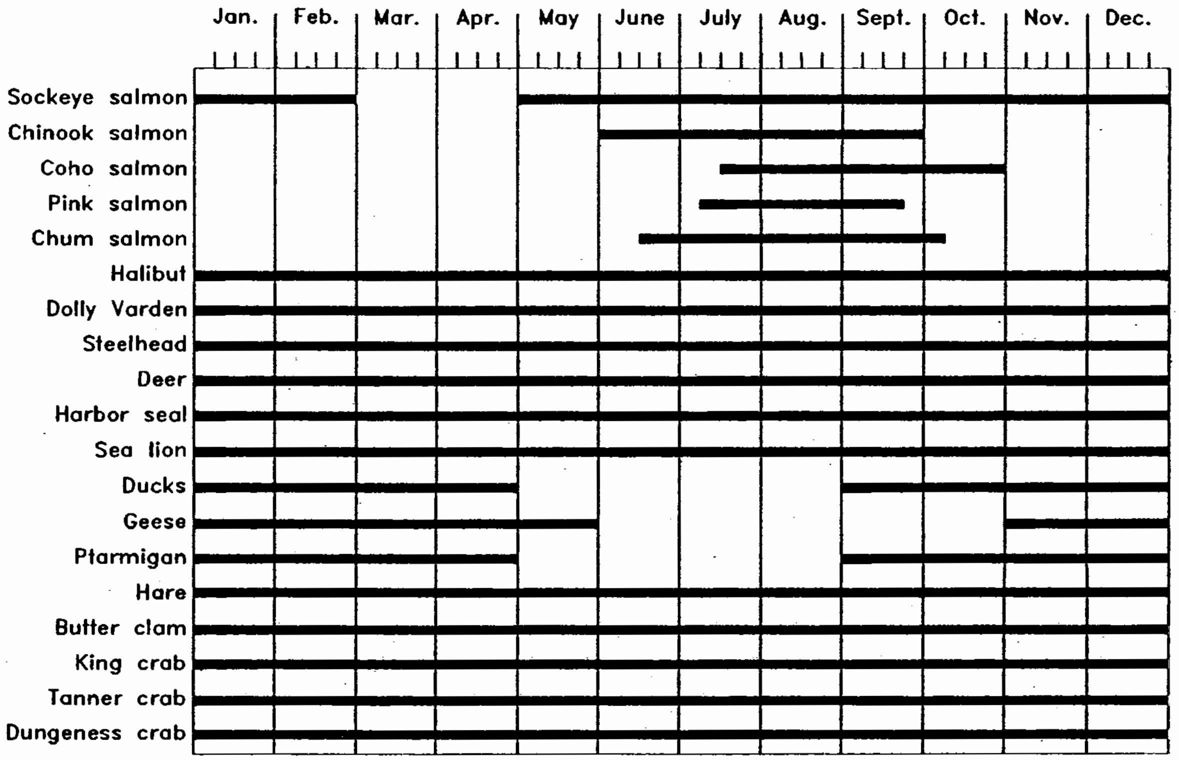
Source: Fall, 1992; Paige, Scott, and Brown, 1991.

Table III.C.3-3
Percentage of Consumable Subsistence Resources used within Selected Resource Categories

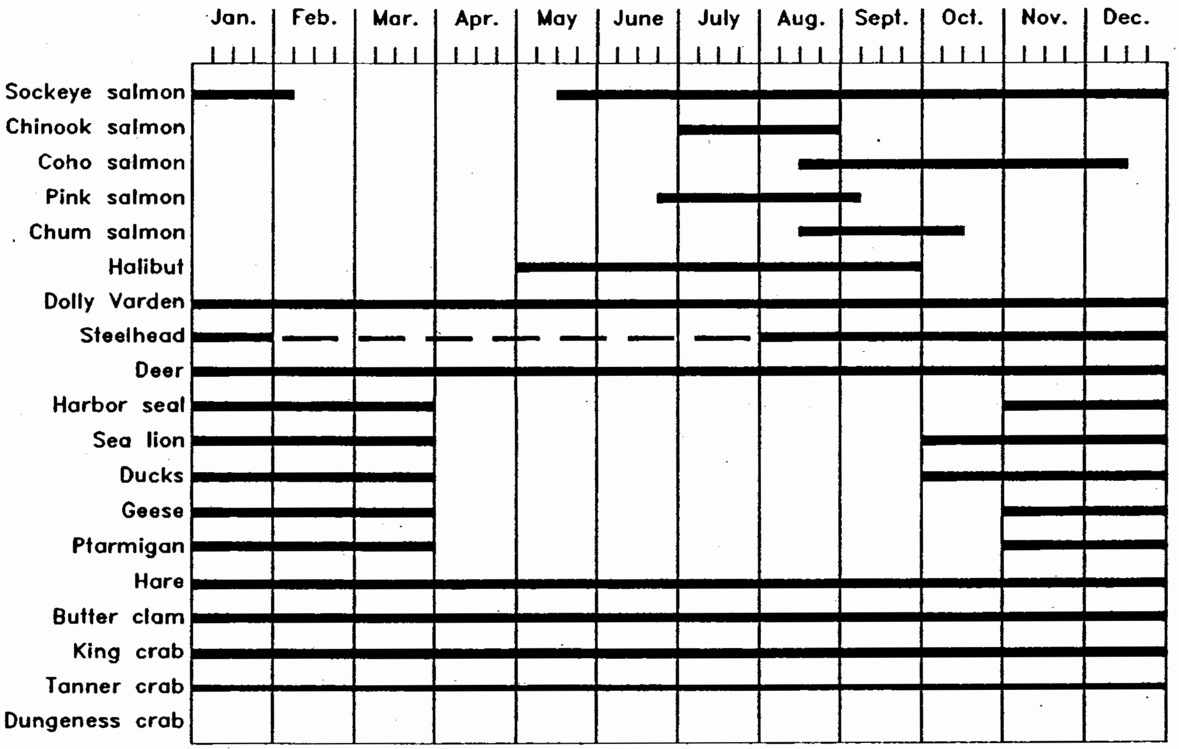
Community	Year	Salmon	Nonsalmon Fish	Big Game	Marine Mammals	Birds and Eggs	Marine Invertebrates
Nanwalek	1987	39	37	3	8	1	6
Port Graham	1987	42	34	2	5	1	7
Tyonek	1983	72	2	21	1	1	2
Akhiok	1986	69	4	19	1	*	6
Karluk	1986	66	11	12	7	1	3
Larsen Bay	1986	49	17	19	2	1	12
Old Harbor	1986	44	10	14	25	1	6
Quzinkie	1986	48	17	17	7	2	7
Port Lions	1986	48	17	23	2	1	10
Chignik	1984	73	12	7	3	1	4
Chignik Lagoon	1984	54	9	26	1	2	7
Chignik Lake	1984	50	6	40	1	1	1
Ivanof Bay	1984	58	4	25	5	2	6
Perryville	1984	55	11	24	5	2	3

Source: See Appendix H.

* Less than 1 percent.



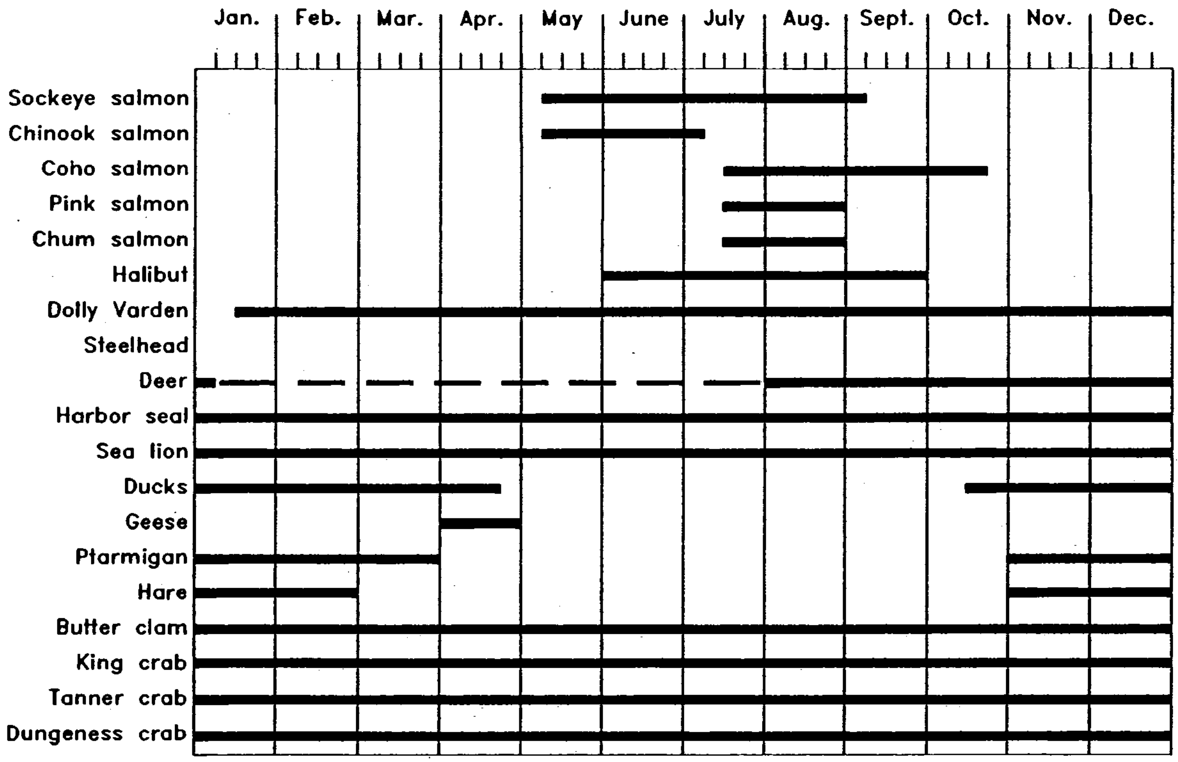
Seasonal round of resource harvests, Akhoik, 1982–1983.



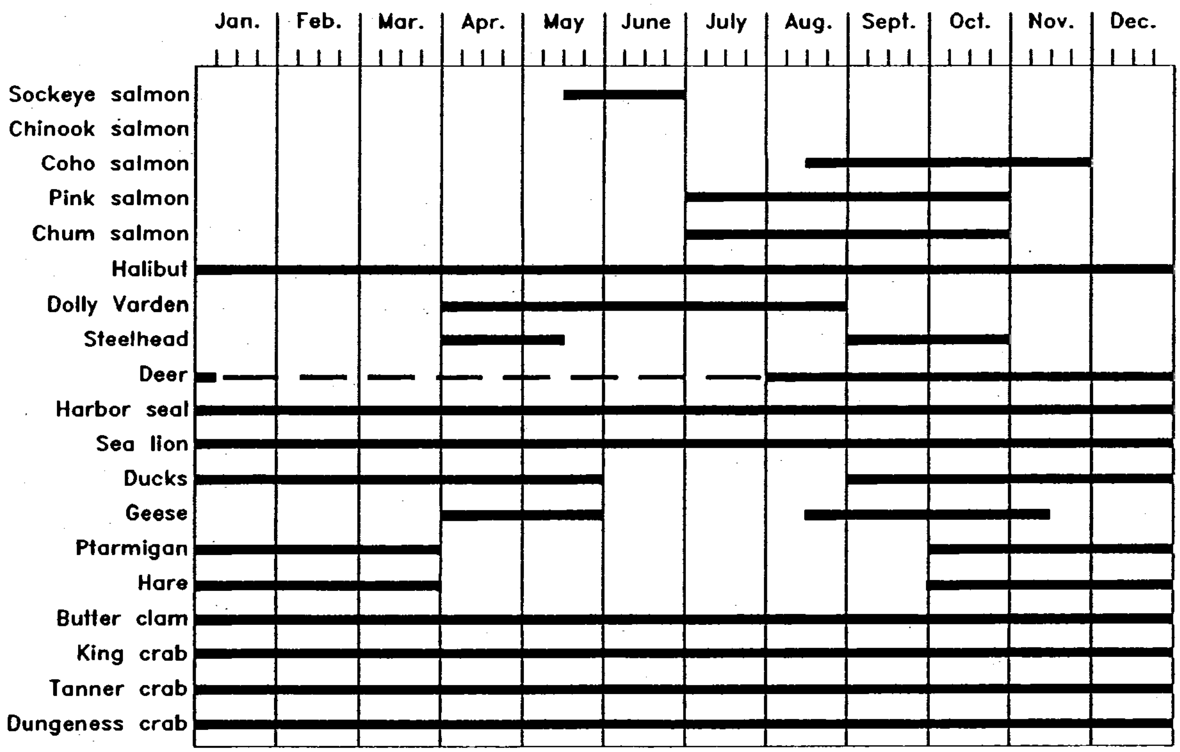
Seasonal round of resource harvests, Old Harbor, 1982–1983.

Source: Schroeder et al., 1987

Figure III.C.3–1 a and b. Seasonal Round of Resource Harvests, 1982–1983 Kodiak Island Nonroad-Connected Villages.



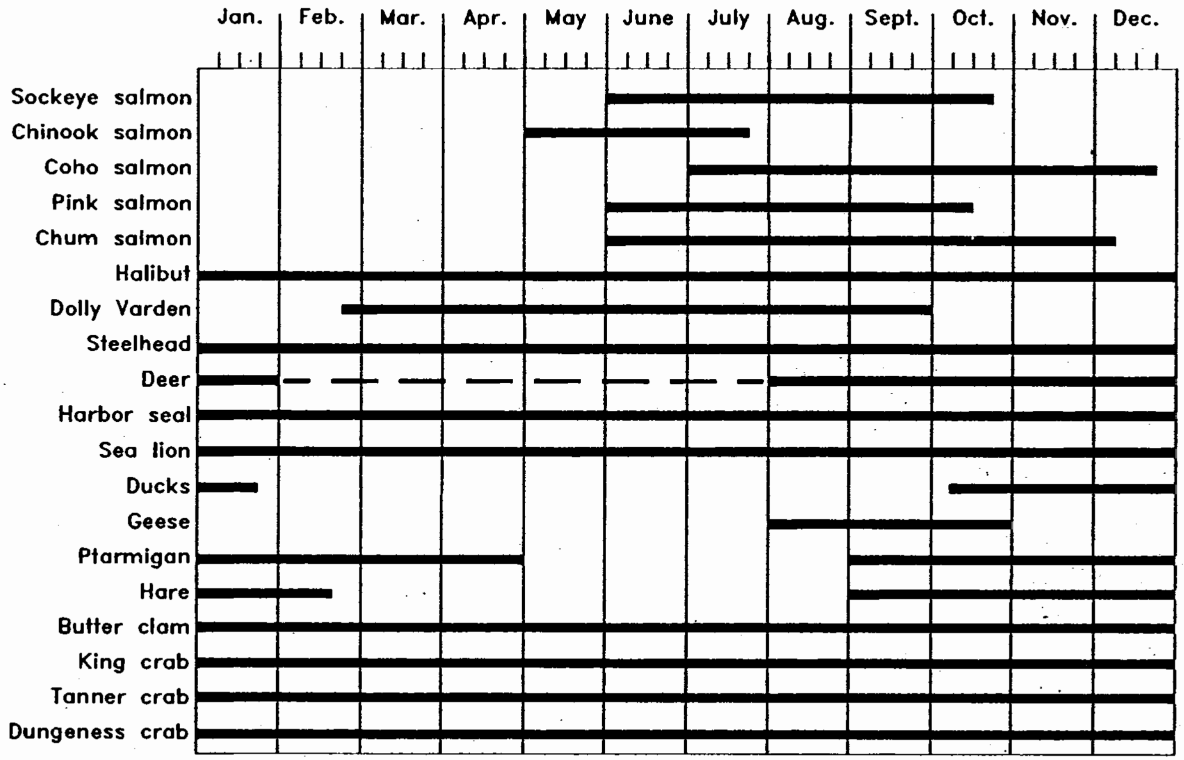
Seasonal round of resource harvests, Karluk, 1982–1983. Solid line indicates when harvest usually takes place. Broken line indicates occasional harvest activity.



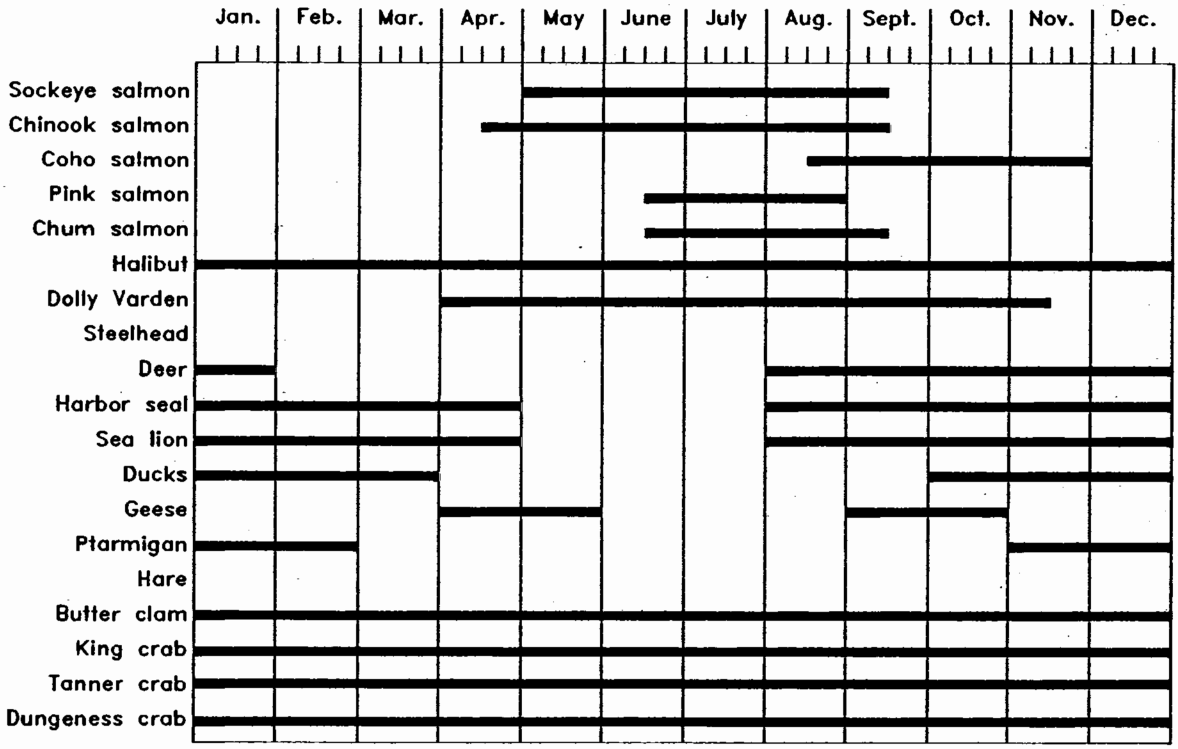
Seasonal round of resource harvests, Ouzinkie, 1982–1983. Solid line indicates when harvest usually takes place. Broken line indicates occasional harvest activity.

Source: Schroeder et al., 1987

Figure III.C.3–1 c and d. Seasonal Round of Resource Harvests, 1982–1983 Kodiak Island Nonroad–Connected Villages.



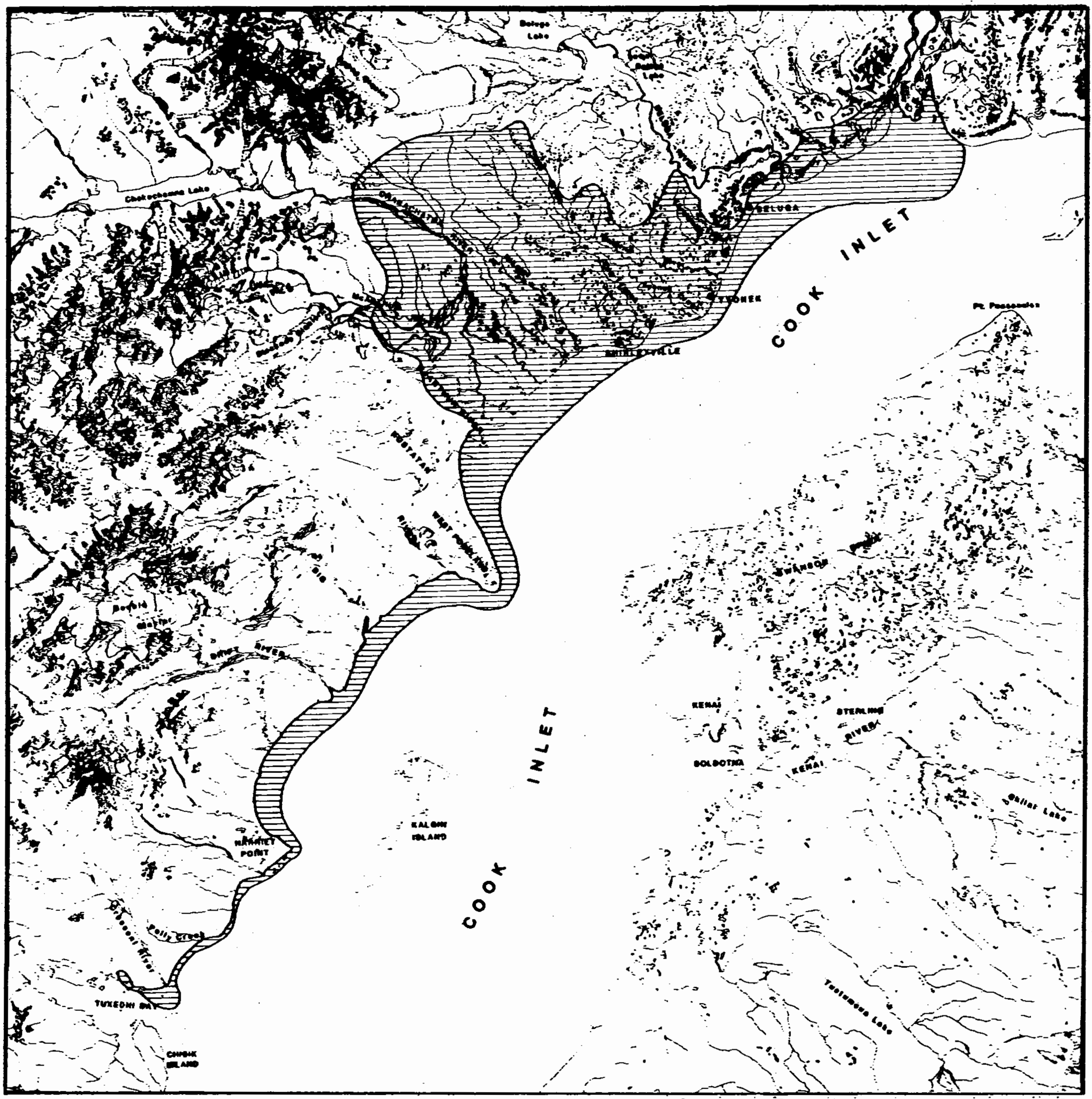
Seasonal round of resource harvests, Larsen Bay, 1982–1983. Solid line indicates when harvest usually takes place. Broken line indicates occasional harvest activity.



Seasonal round of resource harvests, Port Lions, 1982–1983. Solid line indicates when harvest usually takes place.

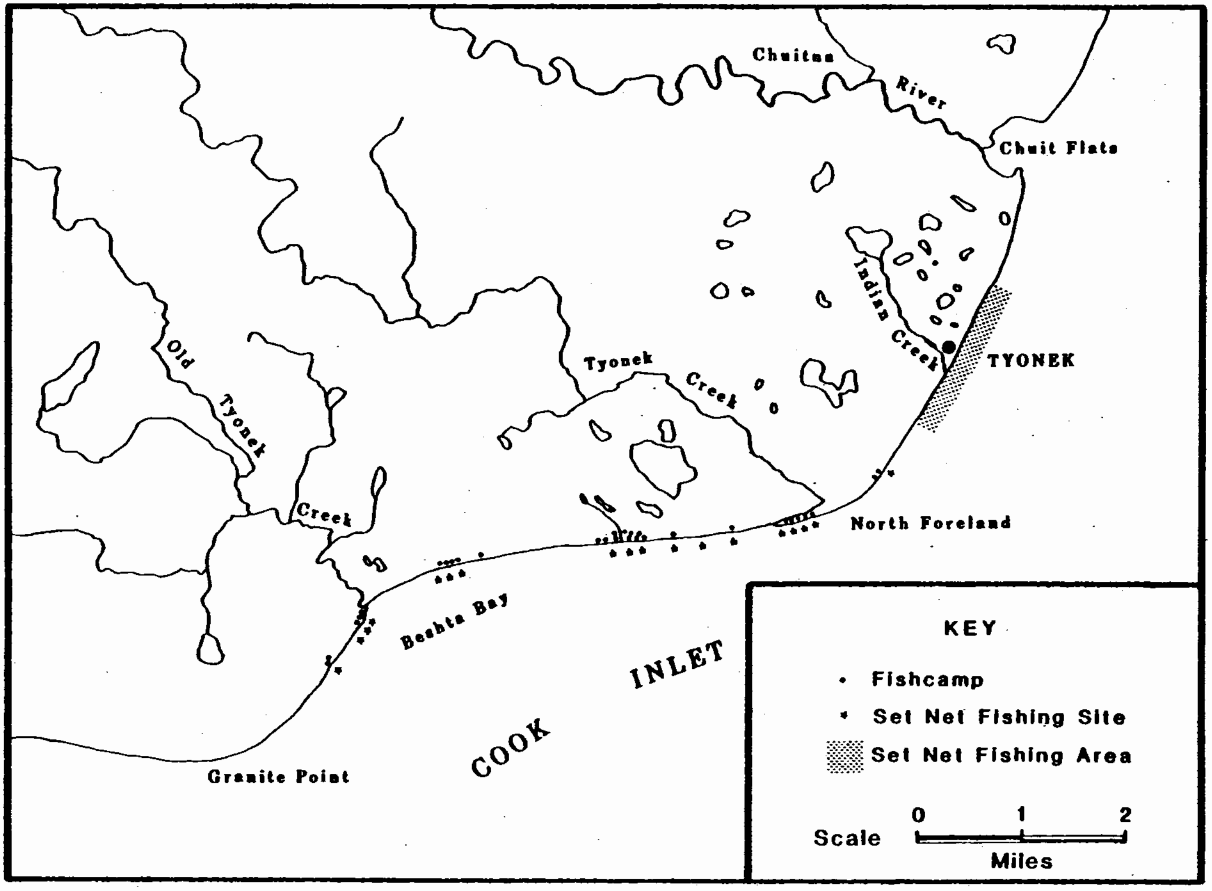
Source: Schroeder et al., 1987

Figure III.C.3–1 e and f. Seasonal Round of Resource Harvests, 1982–1983 Kodiak Island Nonroad–Connected Villages.



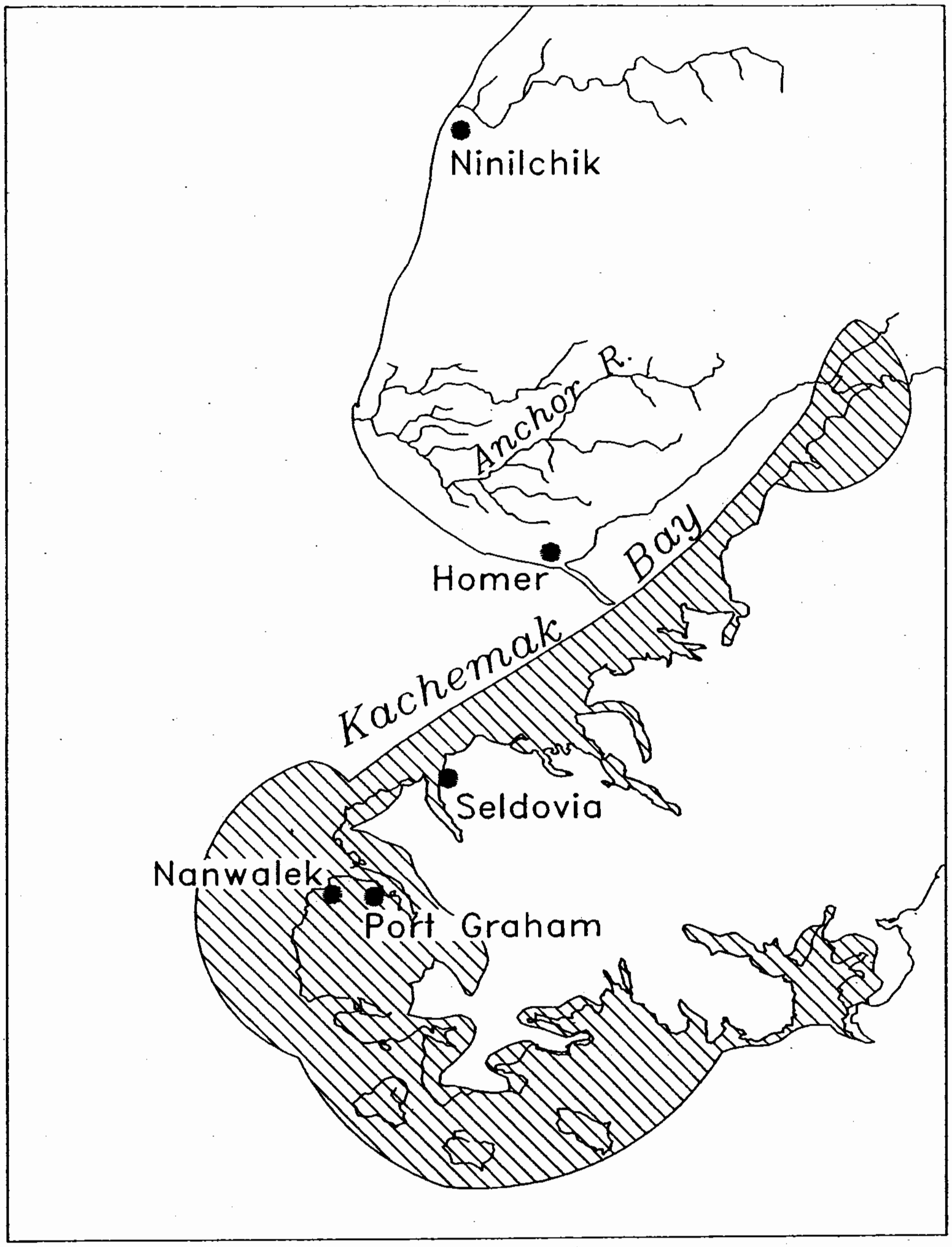
Source: Fall, Foster, and Stanek, 1984.

Figure III.C.3–2a. Composite Resource Harvest Area for Tyonek.



Source: Fall, Foster, and Stanek, 1984.

Figure III.C.3-2b. Tyonek Fishing Sites.



Source: Stanek, 1985.

Figure III.C.3-3. Composite Resource-Harvest Area for Nanwalek and Port Graham.

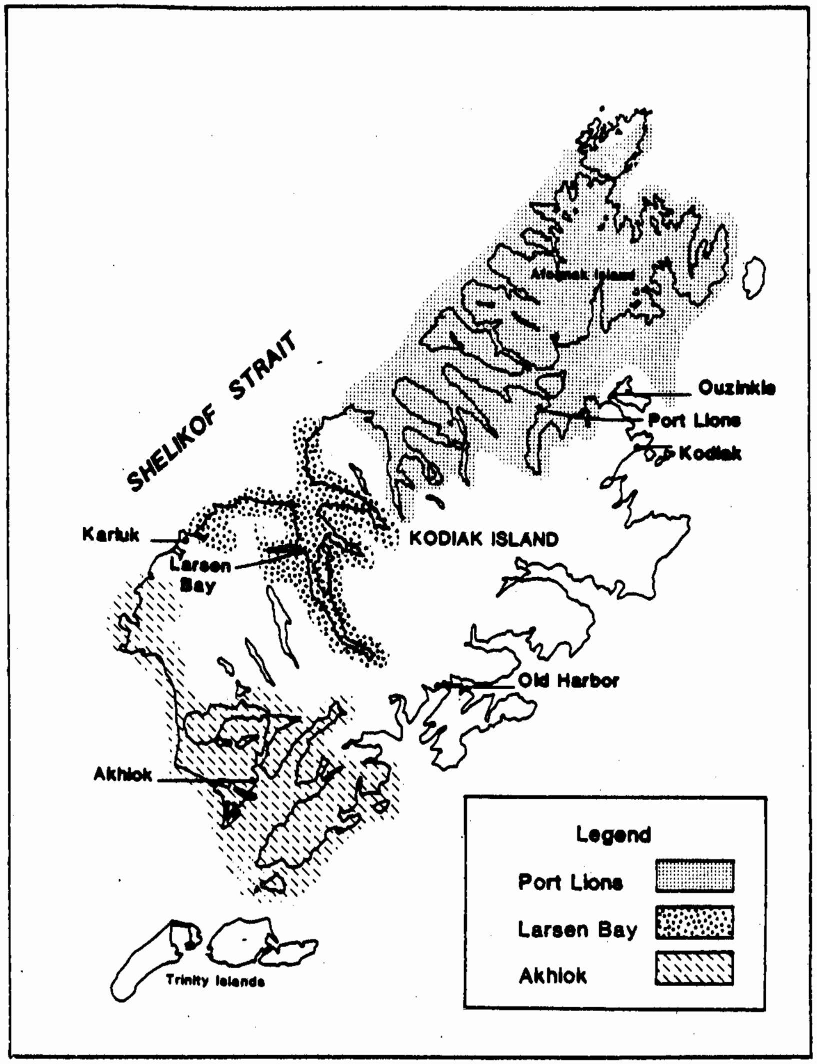
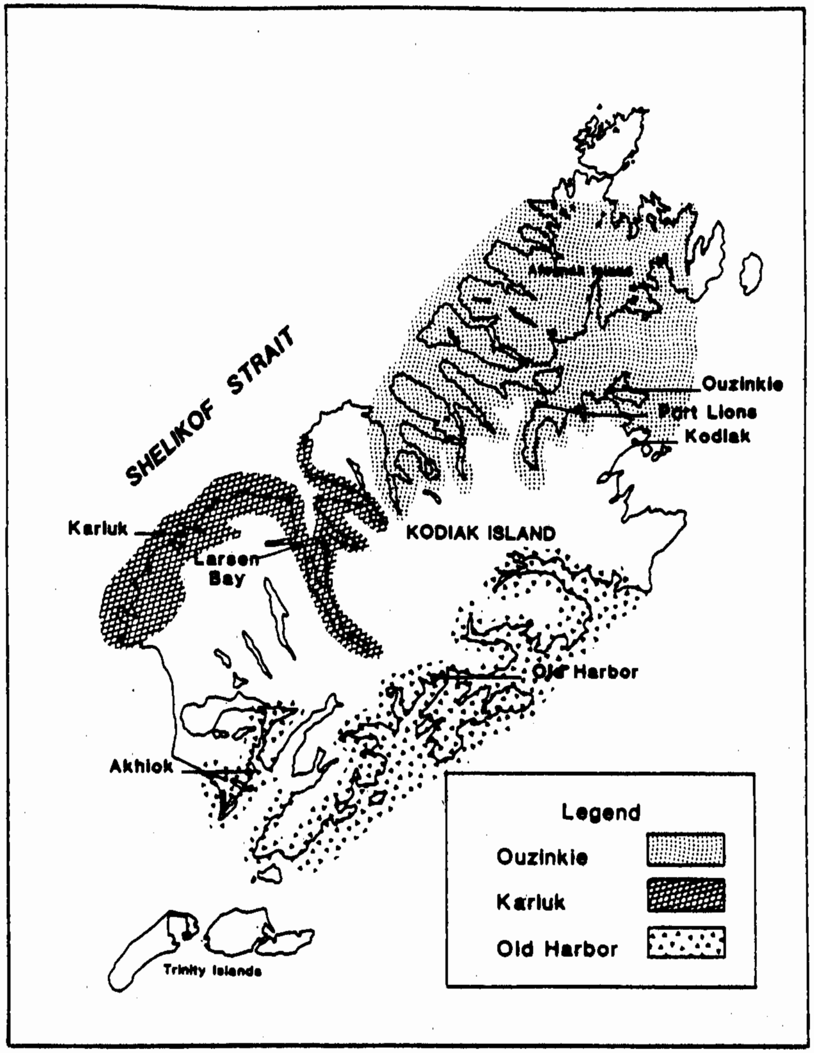
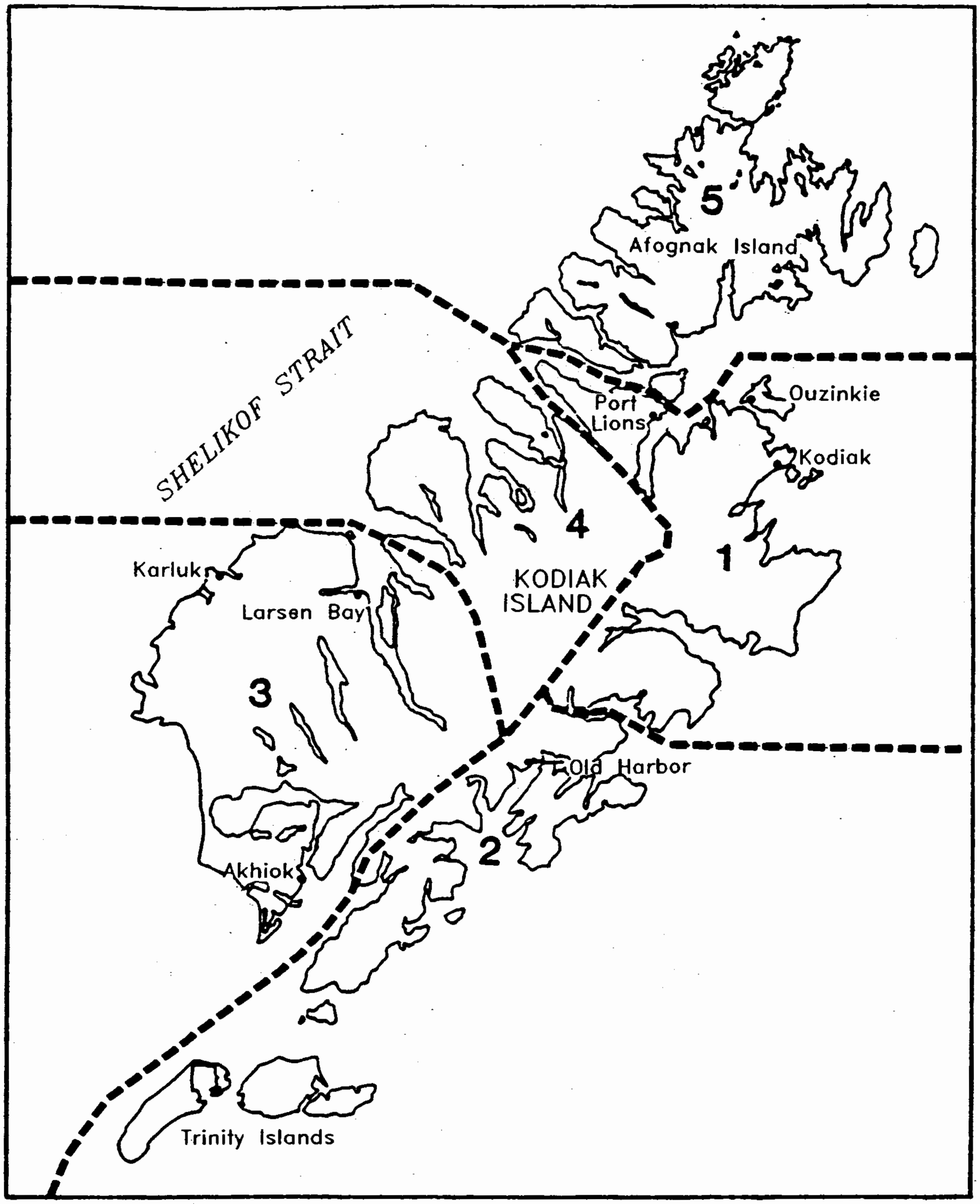


Figure III.C.3-4a. Composite Resource Harvest Areas Known to be Used in 1983. Akhiok, Larsen Bay, and Port Lions.



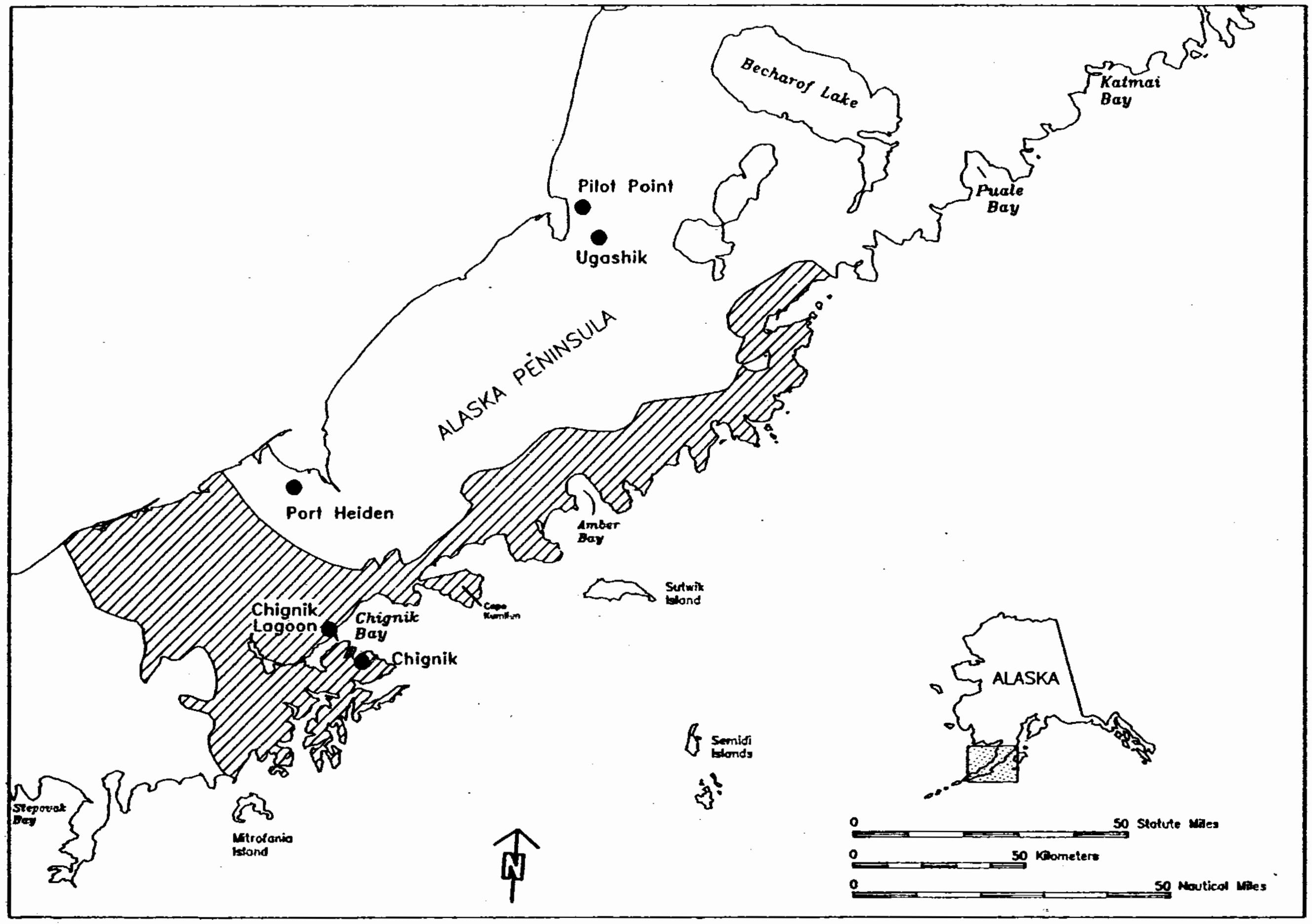
Source: Schroeder et al., 1987

Figure III.C.3-4b. Composite Resource Harvest Areas Known to be Used in 1983. Karluk, Old Harbor, and Ouzinkie.



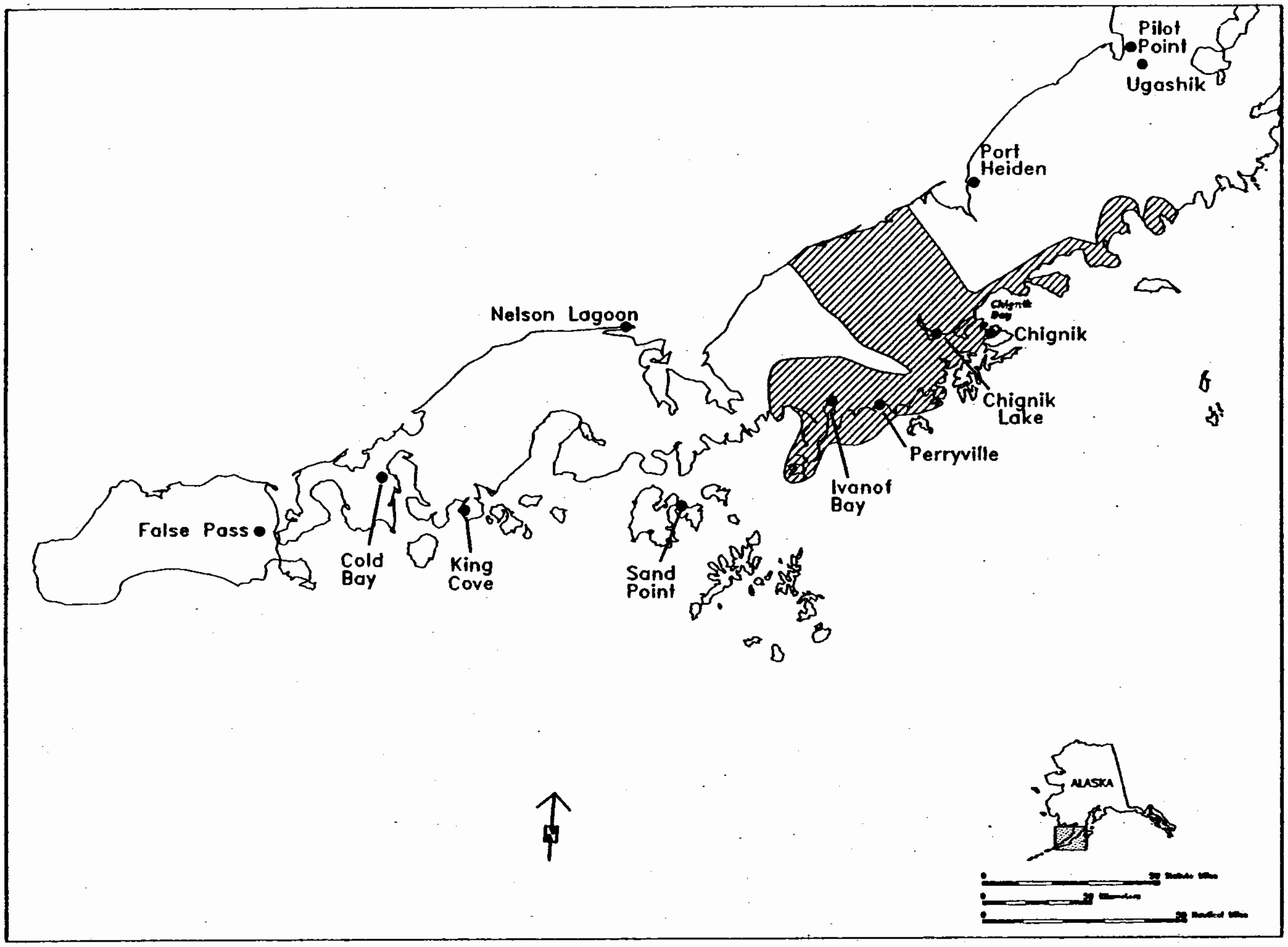
Source: Schroeder et al., 1987

Figure III.C.3-5. Zonal Map of Harvest Areas for Kodiak Road-Connected Area.



Source: Morris, 1987.

Figure III.C.3-6. Composite Resource-Harvest Areas Known to be Used in 1962-1982 -- Chignik and Chignik Lagoon.



Source: Morris, 1987.

Figure III.C.3-7. Composite Resource-Harvest Areas Known to be Used in 1962-1984 -- Chignik Lake, Ivanof Bay, and Perryville.

Table III.C.3-4
Intensity of Use of Hunting and Fishing Areas by Type of Activity by Household, Kodiak Road-Connected Population, 1982 to 1983[a]

Percentage of Households Using Each
(Mean Number of Trips for Each Household in Each Area)

	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Alaska Pen.	Kenai Pen.	Other
Salmon Fishing	74% (11.1)	2% (.2)	5% (.2)	6% (.2)	15% (.6)	2% (.4)	1%[b] (-)	2% (.1)
Halibut Fishing	48% (4.0)	1% (-)	3% (-)	2% (.1)	5% (.1)	- (-)	- (-)	1% (-)
Freshwater Fishing	37% (4.8)	1% (-)	1% (.)	5% (.4)	3% (.1)	- (-)	- (-)	1% (-)
Clam Harvesting	56% (2.5)	1% (-)	2% (-)	3% (.1)	3% (.1)	5% (.1)	- (-)	1% (-)
Crab Harvesting	30% (3.3)	5% (.3)	3% (.1)	1% (-)	2% (.1)	1% (-)	- (-)	1% (-)
Deer Hunting	34% (2.1)	1% (-)	3% (.2)	6% (.3)	12% (.5)	- (-)	- (-)	1% (-)
Brown Bear Hunting	2% (.2)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)
Waterfowl Hunting	8% (.4)	- (-)	- (-)	- (-)	3% (-)	- (-)	- (-)	- (-)
Marine Mammal Hunting	1% (.1)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	1% (-)
Any Harvest Activity	90%	8%	7%	12%	24%	7%	1%	4%

Source: Schroeder, et al., 1987.

[a] See Figure III.C.3-5 for zone locations. Data are from general sample of the road-connected area, excluding Chiniak and Pasagshak. Data are rounded to nearest percentage and nearest decimal point.

[b] Indicates that percent use is <.5 percent, or mean number of trips is <.05. Data are for a 12-month eriod, most often from June 1982 through May 1983.

Table III.C.3-5
Comparison of Subsistence Harvests for Selected Communities Before and After the *Exxon Valdez* Oil Spill

	Per capita dressed weight in pounds, prespill year 1	Per capita dressed weight in pounds, prespill year 2	Per capita dressed weight in pounds, postspill year 1	Postspill change compared to most recent previous year	Postspill change compared to average of all previous years	Per capita dressed weight in pounds, postspill year 2 (preliminary data)
Chenega Bay	309	374	148	-60.4	-56.6	143
Tatitlek	352	644	215	-66.6	-56.8	155
Nanwalek	289	[a]	141	-51.3	[a]	181
Port Graham	227	[a]	122	-46.5	[a]	214
Akhiok	520	162	298	+83.4	-12.7	-
Karluk	863	385	251	-35.0	-59.9	395
Larsen Bay	404	209	210	+0.1	-31.5	340
Old Harbor	491	422	272	-35.6	-40.5	-
Ouzinkie	369	403	89	-78.0	-77.0	205
Port Lions	280	333	146	-56.0	-52.2	-
Chignik	188	[a]	209	+11.1	[a]	[a]
Chignik Lagoon	220	[a]	211	-3.7	[a]	[a]
Chignik Lake	279	[a]	448	+60.1	[a]	[a]
Ivanof Bay	456	[a]	490	+8.4	[a]	[a]
Perryville	391	[a]	394	+1.0	[a]	[a]

Source: Fall, 1992

[a] Only one previous measurement.

NOTE: Two prespill measurements are available for Prince William Sound and Kodiak Island communities. Prespill study years are as follows: Tatitlek, 1987 to 1988 and 1988 to 1989; Chenega Bay, 1984 to 1985 and 1985 to 1986; English Bay and Port Graham, 1987; Kodiak Island Borough, 1982 to 1983 and 1986; Alaska Peninsula, 1984. The "spill year" is 1989 for all communities except Chenega Bay and Tatitlek, for which it is April 1989 to March 1990.

Table III.C.3-6

Predominant Oil-Spill-Related Reasons for Reduction in Overall Subsistence Harvest, Postspill Study Year One (Spill Year)

	Number of Households Surveyed	Household Specifying Spill-Related Reduction		Fear of Contaminated		Too Busy Working to Obtain Subsistence Food	
		Number	Percent	Number	Percent	Number	Percent
Prince William Sound	38	32	84.2	25	65.8	4	10.5
Tatitlek	20	16	80.0	13	65.0	3	15.0
Chenega Bay	18	16	88.9	12	66.7	1	5.6
Lower Cook Inlet	81	68	84.0	51	63.0	49	60.5
Nanwalek	33	30	90.9	22	66.7	24	72.7
Port Graham	48	38	79.2	29	60.4	25	52.1
Kodiak Island:	166	66	39.8	38	22.9	25	15.1
Akniok	10	3	30.0	0	-	3	30.0
Karluk	14	7	50.0	4	28.6	5	35.7
Larsen Bay	31	15	48.4	9	29.0	6	19.4
Old Harbor	45	8	17.8	4	8.9	2	4.4
Ouzinkie	31	18	58.1	13	41.9	3	9.7
Port Lions	35	15	42.9	8	22.9	6	17.1
Alaska Peninsula	101	23	22.8	14	13.9	4	4.0
Chignik	31	5	16.1	3	9.7	1	3.2
Chignik Lagoon	15	7	46.7	2	13.3	2	13.3
Chignik Lake	21	4	19.0	3	14.3	0	-
Ivanof Bay	7	3	42.9	3	42.9	0	-
Perryville	27	4	14.8	3	11.1	1	3.7
Totals	386	189	49.0	128	33.2	82	21.2

Source: Fall, 1991.

Table III.C.3-5 shows prespill harvest data (for 2 years, where available) and postspill harvest data (also for 2 years, for selected communities) by community. These data are reported in per capita dressed weight in pounds, with a comparison of prespill and postspill data reported in percentage of change.

The comparison of subsistence harvests before and after the EVOS (which compares first-year postspill harvest data with either the most recent previous year and an average of all previous years) shows that subsistence harvests in 10 of the 15 communities declined markedly in the first year after the spill, compared to most prespill study years and prespill averages. The communities of Chenega Bay and Tatitlek (located within Prince William Sound) showed harvest reductions of about 60 percent, and the nearby communities of Nanwalek and Port Graham (located within Kachemak Bay) showed declines by about 50 percent. There was a range of decline in subsistence harvests in the Kodiak Island communities, from a high of a 78-percent reduction at Ouzinkie to a low of a 13-percent reduction at Akhiok. In contrast, subsistence harvests in the five Alaska Peninsula communities in the year after the spill were about the same or higher than the single prespill year for which data are available. Preliminary data gathered for the second postspill year showed that harvests for the communities in Prince William Sound still represented less than half the previous harvest levels.

The range of resources used for subsistence purposes in the communities of Prince William Sound, lower Cook Inlet, and Kodiak Island decreased in the first year after the spill (Fall, 1992). This range increased in the second postspill year for most communities but did not return to prespill norms. Using Tatitlek as an example, Fall (1992) indicates that the number of subsistence resources used after the spill (12 in the first year and 14 in the second) declined sharply from the number used in prespill years, which ranged from 20 to 23 resources. (The sharing patterns were similarly affected.) The community of Port Graham showed a similar reduction in the number of resources used in the first postspill year but showed a notable increase in the second postspill year.

Using another example from Prince William Sound, Fall (1992) indicates that change also took place in the use of resource categories during the postspill era. Citing the experience of Chenega Bay, the percentage of sampled households that used fish other than salmon, marine invertebrates, marine mammals, and birds was much lower in the 12 months after the spill than in the 1985 to 1986 prespill study year. In the second post- spill year, the percentage of households in Chenega Bay using fish other than salmon and marine mammals matched the prespill level, while the percentage using marine invertebrates and birds, though up from the year before, remained relatively low.

As shown on Table III.C.3-6, a total of 386 households were surveyed, including 38 in Prince William Sound, 81 in lower Cook Inlet, 166 on Kodiak Island, and 101 on the Alaska Peninsula. Among these, a total of 189 households (49.0 percent of those surveyed) indicated the spill from the *Exxon Valdez* had affected their subsistence harvests, including 32 households (84.2% of those surveyed) in Prince William Sound, 68 households (84.0% of those surveyed) in lower Cook Inlet, 66 households (39.8% of those surveyed) on Kodiak Island, and 23 households (22.8% of those surveyed) on the upper Alaska Peninsula. The most important reason cited was the fear of contaminated subsistence resources, although being too busy working to obtain subsistence food was an almost equally important reason in Nanwalek and Port Graham. To many residents, any level of contamination was considered to be unsafe, although an attempt was made to inform spill-affected communities on the relative safety of consuming subsistence foods (Walker and Field, 1991). Fall (1992) indicates the issue of contamination remained a major concern during the second postspill year as well, especially in Prince William Sound and lower Cook Inlet.

e. **Effects of the EVOS on Subsistence Harvests in Nanwalek and Port Graham:** Research sponsored by MMS into the effects of the EVOS, which spanned 3 years, recently has been published and is the sole citation for this brief discussion (Fall and Utermohle, 1995). Nanwalek and Port Graham are among the communities investigated and are highlighted here because of the impact findings contained in Section IV.

Immediately after the EVOS, subsistence harvests in Nanwalek dropped to half of what had been estimated as "normal" for annual harvests. As noted earlier, employment in cleanup jobs and fear of contamination contributed to this reduction. These "normal" harvest levels were achieved again in study years 1992/93 and 1993/94. Confidence in the edible quality of wild foods increased each year following the spill. Although employment conditions worsened, few households moved away in search of employment; most households responded by increasing subsistence harvests and picking up odd jobs.

The composition of the wild-resource harvests in Nanwalek showed marked consistency when compared over a 6-year period of 1987 to study year 1993/94, despite the dramatic impact of the EVOS. In large part, according to the authors, "this is due to the long-established harvest practices, resource availability, cultural preferences, residents' affinity with their traditional use areas, and relative abundance of local resources." Employment, education, housing availability, and food safety were found to strongly influence harvest patterns.

In Port Graham, per capita subsistence-resource harvests dropped by nearly half during and immediately following the EVOS. By study year 1991\92, per capita harvests surpassed the single prespill measurement available by nearly 25 percent. This was attributed to greater confidence in the safety of wild foods. In study year 1993/94, however, Port Graham's per capita harvests decreased by 24 percent, which partly may be attributed to the deaths of three key resource harvesters and several other community members. Lowered resource abundance also was reported as a factor in the decline. Like its neighbor Nanwalek, Port Graham also showed marked consistency over the years regarding the composition of wild-resource harvests, even in the wake of the EVOS. This consistency is explained for the same reasons given for Nanwalek.

4. **Sociocultural Systems:** The communities and selected places in Southcentral Alaska that could be affected by Lease Sale 149 are shown on Table III.C.4-1. This is the same list of places used in Section III.C.3 (Subsistence-Harvest Patterns). As noted in that section, other settlements in Alaska also might be affected by the lease sale; but the communities and places shown are meant to reasonably represent the area that could be affected by the lease sale.

a. **Characteristics of the Population:** This discussion covers population change over the last decade (1980-1990), ethnic composition of the population in 1990, and selected household and family characteristics of the 1990 population.

(1) **Population Change:** Table III.C.4-1 shows the 1980 and 1990 decennial census population counts, as well as the population increase or decrease for the decade, for selected cities and CDP-named areas within Southcentral Alaska. The population data are organized among the following geographic areas: upper Cook Inlet, central Kenai Peninsula, southern Kenai Peninsula, Kodiak Island (which includes all islands within the Kodiak archipelago), and upper Alaska Peninsula (locally referred to as the Chigniks).

In upper Cook Inlet, the community of Tyonek experienced a reduction in population of 85 to reach a 1990 figure of 154. Among the central Kenai Peninsula communities, the City of Kenai and the unincorporated communities at Sterling and Ridgeway grew by more than 2,000 residents to record 1990 populations of more than 6,000 for Kenai, 3,800 for Sterling, and about 2,000 for Ridgeway. The unincorporated community at Nikiski and the City of Soldotna each grew by more than 1,000 residents during the decade to record 1990 populations of about 3,500 for Soldotna and 2,800 for Nikiski. The other unincorporated places at Clam Gulch, Cohoe, Kalifonsky, Kasilof, and Salamatof each registered positive population growth during the decade. The unincorporated communities at Cohoe and Ridgeway were not identified in the 1980 census of population.

Among the southern Kenai Peninsula communities, the City of Homer experienced the largest growth of about 1,500 residents to reach a 1990 population of 3,660. The second-largest population increase occurred in the unincorporated community at Fritz Creek, which increased by about 1,000 to reach a 1990 population of about 1,400. The City of Seldovia was the only community that experienced a population decline, from a figure of 479 in 1980 to 316 in 1990. The City of Kachemak and the unincorporated places at Anchor Point, Nanwalek (formerly English Bay), Fox River, Halibut Cove, Happy Valley, Nikolaevsk, Ninilchik, and Port Graham each demonstrated positive population growth during the decade of the 1980's. The unincorporated communities at Fox River, Happy Valley, and Nikolaevsk were not identified in the 1980 census of population.

On Kodiak Island, the City of Kodiak grew by more than 1,600 residents to reach a 1990 population of 6,365. The unincorporated community at Women's Bay and the Kodiak (U.S. Coast Guard [USCG]) Station each grew by some 600 residents, with the Station recording a 1990 population of more than 2,000. Among the nonroad-connected communities on the island, the Cities of Akhiok, Larsen Bay, and Old Harbor and the unincorporated community of Karluk experienced population reductions; and the cities of Ouzinkie and Port Lions recorded increased population. The unincorporated communities at Chiniak and Women's Bay were not identified in the 1980 census of population.

Table III.C.4-1
Population by Community and Place

Area	1980	1990	Change
Upper Cook Inlet			
Tyonek CDP[1]	239	15	- 85
Central Kenai Peninsula			
Kenai city	4,324	6,327	2,003
Soldotna city	2,320	3,482	1,162
Clam Gulch CDP	50	79	29
Cohoe CDP		508	
Kalifonsky CDP	92	285	193
Kasilof CDP	201	383	182
Nikiski CDP	1,109	2,743	1,634
Ridgeway CDP		2,018	
Salamatof CDP	334	999	665
Sterling CDP	919	3,802	2,883
Southern Kenai Peninsula			
Homer city	2,209	3,660	1,451
Kachemak city	301	365	64
Seldovia city	479	316	- 163
Anchor Point CDP	226	866	640
Nanwalek CDP (formerly English Bay)	124	158	34
Fox River CDP	382		
Fritz Creek CDP	404	1,426	1,022
Halibut Cove CDP	47	78	31
Happy Valley CDP		309	
Nikolaevsk CDP		371	
Ninilchik CDP	341	456	115
Port Graham CDP	161	166	5
Kodiak Island			
Akhiok city	105	77	- 28
Kodiak city	4,756	6,365	1,609
Larsen Bay city	168	147	- 21
Old Harbor city	340	284	- 56
Ouzinkie city	173	209	36
Port Lions city	215	222	7
Chiniak CDP		69	
Karluk CDP	96	71	25
Kodiak Station CDP	1,370	2,025	655
Women's Bay CDP		620	
Upper Alaska Peninsula			
Chignik city	178	188	10
Chignik Lagoon CDP	48	53	5
Chignik Lake CDP	138	133	5
Ivanof Bay CDP	40	35	5
Perryville CDP	111	108	3

Source: State of Alaska, Department of Labor, Compiler, 1991.

[1] Census Designated Place

On the upper Alaska Peninsula, the five communities of the Chigniks recorded very little population change over the last decade. The City of Chignik maintained the largest nonseasonal population of 188 in 1990. The unincorporated communities of Chignik Lake and Perryville each recorded 1990 populations in excess of 100, while the other unincorporated places at Chignik Lagoon and Ivanof Bay each recorded about half that amount.

(2) **Ethnic Composition of the Population:** Table III.C.4-2 shows a selected representation of the ethnic composition of the 1990 population within the area that could be affected by the lease sale, identifying the Alaskan Native and Asian-American populations that exist among the predominantly Caucasian majority. This is not necessarily the case among some of the smaller communi- ties, such as Tyonek (92% Alaskan Native), Nanwalek (91% Alaskan Native), and Port Graham (90% Alaskan Native) on the southern Kenai Peninsula. On Kodiak Island, the Asian-American community in the City of Kodiak (1,282 residents, or 20% of the population in 1990) outnumbered the Alaskan Native community (811 residents, or 13% of the population). All of the nonroad-connected communities on Kodiak Island are predominantly composed of Alaskan Native residents, including Akhiok (94%), Larsen Bay (84%), Old Harbor (89%), Ouzinkie (85%), Port Lions (68%), and Karluk (92%). In the Chigniks, the communities of Chignik Lake (92%), Ivanof Bay (94%), and Perryville (94%) are predominantly Alaskan Native communities, whereas the City of Chignik and Chignik Lagoon are more evenly divided among the different ethnic groups.

(3) **Selected Characteristics of the Population:** Table III.C.4-3 shows selected characteristics of the 1990 population within the area that could be affected by the lease sale, including the number of households per community, the average number of persons per household, and the median age of residents in the community. Among the communities with populations of more than 1,000 residents, the City of Homer in 1990 had both the lowest average number of persons per household (2.54) and the highest median age (32.4 years). The community at Sterling had the highest average number of persons per household (2.96), and the City of Kenai registered the lowest median age (28.6 years). These characteristics were distributed within these limits among the other large communities. Among the other communities of the upper Cook Inlet and central Kenai Peninsula, median age ranged from 29.1 at Tyonek to 32.9 at Kasilof. The average number of persons per household ranged from 2.72 at Clam Gulch, Cohoe, and Salamatof to 3.07 at Nikiski.

In the southern part of the Kenai Peninsula, the lowest median age in 1990 was registered among the residents at Fox River (14.0 years) and Nikolaevsk (15.7 years), whereas the highest median age was found at Happy Valley (36.7 years), Ninilchik (37.0 years), and Halibut Cove (40.9 years). (Residents of Fox River and Nikolaevsk are predominantly of Russian descent. Of the total ancestries reported, 96.9 percent [377 of 389 reported] of Fox River residents cited Russian ancestry, while 73.0 percent [352 of 482 reported] of Nikolaevsk residents cited Russian ancestry.) The lowest numbers of persons per household were found in Halibut Cove (1.70 persons), Seldovia (2.45 persons), and Ninilchik (2.46 persons). The highest number of persons per household (with the exception of Fox River and Nikolaevsk) were found in Nanwalek (3.76 persons), Fritz Creek (2.90 persons), Port Graham (2.77 persons), and Anchor Point (2.76 persons). The predominantly Alaskan Native communities of Nanwalek and Port Graham demonstrated quite different characteristics, with Nanwalek having a younger population (median age of 20.0 years) than Port Graham (median age of 30.7 years) and a larger number of persons per household (3.76 in Nanwalek and 2.77 in Port Graham).

Among the small, nonroad-connected communities on Kodiak Island and in the Chigniks, the highest numbers of persons per household in 1990 were found in Akhiok (4.04 persons), Karluk (3.94 persons), Chignik Lake (3.91 persons), and Ivanof Bay (3.89 persons). The lowest numbers of persons per household were found in Port Lions (3.04 persons), Ouzinkie (3.07 persons), and Chignik Lagoon (3.12 persons). Considering the median age of the population, Karluk (19.4 years), Akhiok (21.3 years), Chignik Lake (22.4 years), and Ivanof Bay (22.8 years) registered the lowest, whereas Ouzinkie (31.5 years), Chignik Lagoon (29.4 years), Port Lions (28.5 years), Chignik (28.1 years), and Perryville (28.0 years) recorded the highest.

b. **Social Characteristics of the Communities:** The communities within the area that could be affected by the lease sale are grouped for discussion purposes into the major population and commercial-industrial centers and the smaller, nonroad-connected communities in (1) the upper Cook Inlet and Kenai Peninsula area and (2) the Kodiak Island and upper Alaska Peninsula area.

(1) **Upper Cook Inlet and Kenai Peninsula Communities:** The Kenai-Soldotna area, which provides diversified social, commercial, and other services for residents of the central-Kenai Peninsula area,

Table III.C.4-2
Ethnic Composition of the Population, 1990
Count and Percentage of Total Count, by Place

Area	White		Alaska Native		Asian	
Upper Cook Inlet						
Tyonek CDP	12	(8)	142	(92)	0	(0)
Central Kenai Peninsula						
Kenai city	5,604	(89)	535	(8)	96	(2)
Soldotna city	3,267	(94)	158	(5)	37	(1)
Clam Gulch CDP	68	(86)	10	(13)	1	(1)
Cohoe CDP	490	(96)	9	(2)	2	(1)
Kalifonsky CDP	270	(95)	12	(4)	3	(1)
Kasilof CDP	371	(97)	11	(3)	0	(0)
Nikiski CDP	2,551	(93)	168	(6)	19	(1)
Ridgeway CDP	1,867	(93)	93	(5)	36	(2)
Salamatof CDP	854	(85)	104	(10)	5	(1)
Sterling CDP	3,674	(97)	79	(2)	33	(1)
Southern Kenai Peninsula						
Homer city	3,463	(95)	130	(6)	54	(1)
Kachemak city	346	(95)	11	(3)	8	(2)
Seldovia city	259	(82)	48	(15)	5	(2)
Anchor Point CDP	828	(96)	32	(4)	5	(1)
Nanwalek CDP (formerly English Bay)	14	(9)	144	(91)	0	(0)
Fox River CDP	382	(100)	0	(0)	0	(0)
Fritz Creek CDP	1,361	(95)	48	(3)	8	(1)
Halibut Cove CDP	74	(95)	3	(4)	0	(0)
Happy Valley CDP	287	(93)	19	(6)	3	(1)
Nikolaevsk CDP	359	(97)	5	(1)	7	(2)
Ninilchik CDP	367	(80)	89	(20)	0	(0)
Port Graham CDP	15	(9)	150	(90)	1	(1)
Kodiak Island						
Akhiok city	4	(5)	72	(94)	1	(1)
Kodiak city	4,028	(63)	811	(13)	1,282	(20)
Larsen Bay city	21	(14)	124	(84)	2	(1)
Old Harbor city	29	(10)	252	(89)	0	(0)
Ouzinkie city	28	(13)	178	(85)	0	(0)
Port Lions city	68	(31)	150	(68)	2	(1)
Chiniak CDP	63	(91)	4	(6)	2	(3)
Karluk CDP	5	(7)	65	(92)	1	(1)
Kodiak Station CDP	1,814	(90)	34	(2)	75	(4)
Women's Bay CDP	541	(87)	65	(10)	9	(1)
Upper Alaska Peninsula						
Chignik city	92	(49)	85	(45)	9	(5)
Chignik Lagoon CDP	23	(43)	30	(57)	0	(0)
Chignik Lake CDP	11	(8)	122	(92)	0	(0)
Ivanof Bay CDP	2	(6)	33	(94)	0	(0)
Perryville CDP	6	(6)	102	(94)	0	(0)

Source: State of Alaska, Department of Labor, Compiler, 1991.

Table III.C.4-3
Selected Characteristics of the Population, 1990

Area	Number of Households	Avg. No. Persons per Household	Median Age
Upper Cook Inlet			
Tyonek CDP	55	2.80	29.1
Central Kenai Peninsula			
Kenai city	2,329	2.70	28.6
Soldotna city	1,284	2.69	29.5
Clam Gulch CDP	29	2.72	31.5
Cohoe CDP	187	2.72	32.3
Kalifonsky CDP	99	2.88	31.5
Kasilof CDP	125	3.05	32.9
Nikiski CDP	888	3.07	30.4
Ridgeway CDP	686	2.94	31.1
Salamatof CDP	264	2.72	31.5
Sterling CDP	1,283	2.96	31.7
Southern Kenai Peninsula			
Homer city	1,411	2.54	32.4
Kachemak city	140	2.61	34.6
Seldovia city	129	2.45	35.5
Anchor Point CDP	314	2.76	32.9
Nanwalek CDP (formerly English Bay)	42	3.76	20.0
Fox River CDP	67	5.70	14.0
Fritz Creek CDP	491	2.90	30.9
Halibut Cove CDP	23	1.70	40.9
Happy Valley CDP	118	2.62	36.7
Nikolaevsk CDP	80	4.64	15.7
Ninilchik CDP	185	2.46	37.0
Port Graham CDP	60	2.77	30.7
Kodiak Island			
Akhiok city	19	4.05	21.3
Kodiak city	2,051	2.92	30.6
Larsen Bay city	44	3.34	23.5
Old Harbor city	87	3.26	23.2
Ouzinkie city	68	3.07	31.5
Port Lions city	73	3.04	28.5
Chiniak CDP	23	3.00	35.2
Karluk CDP	18	3.94	19.4
Kodiak Station CDP	414	3.80	24.4
Women's Bay CDP	220	2.82	31.5
Upper Alaska Peninsula			
Chignik city	46	3.48	28.1
Chignik Lagoon CDP	17	3.12	29.4
Chignik Lake CDP	34	3.91	22.4
Ivanof Bay CDP	9	3.89	22.8
Perryville CDP	31	3.48	28.0

Source: State of Alaska, Department of Labor, Compiler, 1991.

includes the cities of Kenai and Soldotna as well as the residential areas outside these cities in places such as North Kenai or Nikiski, Sterling, Ridgeway, Salamatof, and Kasilof. The Homer area (centered around the City of Homer but also including the residents of places such as Fritz Creek, Anchor Point, Nikolaevsk, Ninilchik, and Kachemak city) serves a smaller scale but similar function for residents of the southern Kenai Peninsula and Kachemak Bay area as well as being an important fishing community (Braund and Behnke, 1980).

(a) Kenai-Soldotna Area: The social fabric and economy of the Kenai-Soldotna area have been shaped since the late 1950's predominantly by the discovery and development of oil and gas resources nearby on the Kenai Peninsula and in Cook Inlet (USDOI, MMS, Alaska OCS Region, 1984). The small-scale society of the Kenai-Soldotna area, highly valued by most of its residents, is being transformed by this economic stimulus into a more impersonal urban society as population rapidly increases and more specialized urban functions develop. This transition and sense of transiency is increasingly accompanied by the loss of certain valued social qualities, including a sense of community and small-town atmosphere. Reciprocity and personal contacts are being replaced by the increasing importance of more impersonal and market relationships (Braund and Behnke, 1980).

The Kenai-Soldotna area represents in certain respects an extension of the cultural and socioeconomic patterns of the Anchorage area—the transportation of an urban settlement pattern and economic system to the Kenai Peninsula. Hunting and fishing practices reflect substantial differences between households that use wild resources and a large proportion of households are nonusers of such resources, reflecting the heterogeneity of the socioeconomic system. No extensive distribution and exchange networks exist to integrate members of the community; no cultural rules prescribe distribution as expected or proper behavior (Georgette, 1983).

(b) Homer Area: In contrast, the Homer area is more sparsely populated and has not been subject to the major economic fluctuations that have characterized the development of the Kenai-Soldotna area. Furthermore, the Homer area is economically dependent on commercial fishing and tourism rather than the oil and gas industry. Socially diverse, with a wide variety of lifestyles and ways of life, the Homer area has shown considerable sociocultural continuity and stability despite rapid population growth. This is attributed to the strong ties residents have developed to maintaining the local natural environment (Braund and Behnke, 1980). Newcomers, arriving in the area for various reasons, have adapted to the three basic ecologic-economic niches the Homer area provides: commercial fishing, trade, and subsistence fishing and farming. All value their independence and many are seeking to establish self-sufficient, self-reliant ways of life (Braund and Behnke, 1980). Because of the diversity and individualism of the area's residents, however, residents of the area surrounding Homer and city residents themselves sometimes support different positions on economic development (Braund and Behnke, 1980).

Self-perceptions of many Homer residents include the area's small-town and country like attributes—attributes that are linked to the use of local fish and game resources by a sizable portion of the population. Households that do hunt and fish generally schedule such activities around wage employment and target a narrow range of resources, including silver salmon, halibut, mussels, and clams as well as trout, moose, and berries. The family unit constitutes a primary production unit, although lateral ties of mutual aid exist through nonrelatives working together in resource harvests (Reed, 1983).

(c) Small, Nonroad-Connected Communities: The small, nonroad-connected communities in upper Cook Inlet include Tyonek, Nanwalek, Port Graham, and Seldovia. Residents of Tyonek are predominantly Tanaina (Dena'ina) Athapaskan Indians, whereas residents of Nanwalek and Port Graham are predominantly Alutiiq people that locally think of themselves as Aleuts (Braund and Behnke, 1980); Seldovia is a more heterogeneous community. The sociocultural systems of these small coastal communities are supported by a limited economic base, with commercial fishing and seafood processing as the primary income-producing occupations. Maintenance of subsistence activities is considered central to the social well-being of the communities of Tyonek, Nanwalek, and Port Graham and less so in Seldovia, although Alaskan Native residents there appreciate the importance of these activities. In Tyonek, for example, hunting and fishing patterns more closely resemble those of communities such as Nondalton and Dot Lake than those of communities on the nearby Kenai Peninsula (Fall, 1983). Subsistence activities in Tyonek are characterized by a well-established annual round of hunting, fishing, and gathering activities; the use of a wide range of marine and land resources; and a kinship-based system for the harvest, processing, distribution, and exchange of wild-resource products (Schroeder et al., 1987).

In Nanwalek and Port Graham, a considerable network of resource sharing and distribution exists within each community, because the communities are closely related by family ties, common hunting and fishing practices, and local customs. Russian Orthodox holidays, name days, and birthdays, among others, are occasions for celebration and use of locally harvested foods; and many daily meals of families in these communities incorporate similar resources. Subsistence and commercial fishing activities, as well as visiting, recreation, and political relationships, are primarily based on the complex web of kinship networks and family relationships in these communities. Residents feel a strong bond to their communities, both to the physical surroundings and to their relatives and friends (Braund and Behnke, 1980).

Seldovia, on the other hand, is a multiethnic community that has a character similar to other rural, white, frontier fishing towns (Braund and Behnke, 1980). Seldovia at the turn of the century was a thriving commercial-fishing community and the center for commercial and social life for all of Kachemak Bay and Cook Inlet (Reed, 1983). Many Scandinavian and other fishermen immigrated to Seldovia and intermarried with the local population. It was not until the 1960's that other commercial centers outgrew Seldovia and diminished its commercial importance. Seldovia today has an Alaskan Native population of Eskimo, Athapaskan, and Aleut heritage (Reed, 1983) and a shrinking population (see Table III.C.5-1). Socially, the community is portrayed as more polarized into different social groups than before the 1964 earthquake and subsequent renewal of the waterfront (Braund and Behnke, 1980).

(2) **Kodiak Island and Upper Alaska Peninsula Communities:** The City of Kodiak and its surrounding road-connected residential areas provide diversified social, commercial, and other services for residents of Kodiak Island as well as an important commercial-fishing port. Residential areas outside Kodiak proper include places such as Chiniak, Kodiak (USCG) Station, and Women's Bay. A similar core area does not exist among the upper Alaska Peninsula communities.

(a) **Kodiak Area:** The City of Kodiak is the largest and most culturally diverse community on Kodiak Island, representing different cultural backgrounds and traditions. Kodiak originated in the Russian era and evolved into a commercial-fishing center before the turn of the century. The emphasis on fishing has persisted to the present and has been a unifying force in the community. A less seasonal and more dependable year-round economy for the community was established in the late 1940's with diversification into crab and other species. Kodiak's downtown waterfront district was severely damaged by a tsunami generated by the 1964 earthquake, but the area was almost entirely rebuilt by 1970. Today, Kodiak is the home of the largest commercial fishing fleet in Alaska (USDOI, MMS, Alaska OCS Region, 1984).

The interests and concerns of the fishing industry permeate Kodiak's entire social fabric. In keeping with fisheries traditions, a relatively large group of resident and transient workers who process the catch are supported onshore. Like the fishing fleet and shore side workers, other residents of Kodiak also are drawn into the predominantly fisheries way of life, with its danger, intensity, and commitment as well as its recreational, social, and political imperatives. The isolation and relatively small size of the Kodiak area encourage rapid organization and mobilization around key issues affecting the community. Issues that could affect the fisheries way of life have tended to mobilize considerable unity within the community (USDOI, MMS, Alaska OCS Region, 1984).

(b) **Small, Nonroad-Connected Communities:** The small, nonroad-connected communities of the Kodiak Island and upper Alaska Peninsula area that could be affected by the lease sale include Akhiok, Karluk, Larsen Bay, Old Harbor, Ouzinkie, and Port Lions on Kodiak Island and Chignik, Chignik Lagoon, Chignik Lake, Ivanof Bay, and Perryville on the upper Alaska Peninsula.

This description is based primarily on the results of a study sponsored by MMS of the small communities on Kodiak Island and the upper Alaska Peninsula (Cultural Dynamics, Inc., 1986a). All of these communities are physically isolated, although linked by year-round air transportation to other Alaskan communities and regional centers. In addition to providing a detailed description, the study found that (1) dual residency is an established pattern among the five Alaska Peninsula communities; (2) social and kinship links appear greater between the southern Kodiak Island communities and the Alaska Peninsula, and between Chignik and Kodiak City, than between the southern and northern Kodiak communities; and (3) several traditional family patterns—such as households containing three generations of people—persist, especially in the southern Kodiak communities.

Table III.C.5-1 Blocks That Have A High Potential for Prehistoric Resources.

Protraction Diagram	Blocks
NO 5-1	438-440,479--484, 522-528, 566-572, 610-611, 613-616, 657-660, 701-704, 741-742, 744-748, 785-792, 829-835, 873-878, 918-922, 962-966, 1006-1009
NO 5-2	222-224, 265-269, 309-313, 306-357, 399-401, 444-447, 485-487, 490-493, 529-531, 534-536, 573-575, 578-579, 617-618, 661-662, 705
NO 5-3	41, 304-305, 347-348, 391, 475, 518-519, 562
NO 5-5	20-21, 23-24, 64-65, 321-322, 364-366, 408-409, 451-452

Source: Appendix F, Prehistoric Resources Analysis

The Kodiak/Alaska Peninsula area includes three very old communities (Karluk, Akhiok, and Chignik); three relatively new communities (Chignik Lake, Ivanof Bay, and Port Lions) established since 1950; and a shared linguistic and cultural foundation. These Alutiiq people experienced Russian influences, especially in the northern Kodiak Island area, as well as the rapid expansion of commercial salmon fisheries and canneries in the late 19th century, where influences were felt especially strongly in the Karluk, Chignik, and Chignik Lagoon areas (from cannery operations located nearby). The Scandinavian influence was greatest in the Chignik and Chignik Lagoon areas. Contact between the upper Alaska Peninsula area and Kodiak Island may have been frequent in the first part of the 20th century, with travel, visiting, and intermarriage occurring during the fur-trading and early commercial-fishing period. Kinship ties through marriage continue to link the Kodiak Island communities with the Pacific coast side of the Peninsula; there are very few marriages between residents born on the southern end of Kodiak Island, especially Old Harbor and Akhiok, and northern-end residents. Community migration patterns emerging in the period 1984 to 1985 indicated a movement of families from a smaller to the nearest larger community on Kodiak Island—from Karluk to Larsen Bay, from Akhiok to Old Harbor, and from Ouzinkie to Port Lions.

Church affiliation for all communities originally was Russian Orthodox, although Perryville, Chignik Lake, Karluk, Akhiok, and Old Harbor are the only exclusive Orthodox communities. Ivanof Bay is exclusively Protestant, with this being a reason for the creation of the community from former Perryville residents. Chignik, Chignik Lagoon, Larsen Bay, Ouzinkie, and Port Lions have both Orthodox and Protestant traditions.

Seasonality of residency in the Kodiak Island and upper Alaska Peninsula communities is based on the rhythms of commercial fishing. This is more marked on the Alaska Peninsula than on Kodiak Island, with Chignik and Chignik Lagoon expanding greatly in June as many residents from the other communities migrate for summer salmon fishing.

(c) <u>Fisheries Orientation</u>: Most all the Kodiak Island and Chignik area communities share a tradition of commercial fishing, but the level of participation varies importantly from one community to another. According to Langdon (Cultural Dynamics, Inc., 1986b), community groupings were evident in the early 1980's based on participation in commercial fisheries. Chignik Lake, Perryville, and Ivanof Bay fishers were almost totally dependent on traditional salmon fishing with sparse evidence of investment in large boats or participation in winter crab fisheries. These traditional fishers were independent vessel owners, demonstrated greater reliance on kinsmen for crew members, and continued to maintain relationships with processors for services. Fishers from Chignik and Chignik Lagoon, on the other hand, showed more diversification, with some having ventured into king and tanner crab in the 1970's and the trend being toward further diversification of species harvested. Fishers from these two communities tended to hire more nonrelatives and nonlocal crewmen, although there still was a strong reliance on kinsmen for salmon fishing. Ties with processors were very weak, because these fishers bargained independently with local and outside processors.

A similar pattern of substantial involvement and diversification existed on Kodiak Island among the communities of Old Harbor, Port Lions, and Ouzinkie, although traditional fishers also were present. Of these communities, Port Lions appeared to be the most similar to Kodiak city in the size of vessels, the fisheries pursued, and the proportion of total earnings derived from different species.

A third community pattern was one of declining involvement in commercial fisheries, a pattern found in Larsen Bay, Akhiok, and Karluk—originally traditional salmon-oriented communities. Fishers from these communities had sold most of their permits, particularly set-gillnet permits, for a variety of reasons, such as poor local harbors, lack of vessel- and gear-storage facilities, disasters, and poverty. Although commercial fishing was still important to residents of Larsen Bay, participation was declining as those who could not or would not diversify left the fishery. Residents of Akhiok and Karluk appeared to be only minimally involved in commercial fisheries.

c. **<u>Institutional Organization of the Communities</u>**: The communities that could be affected by the proposed lease sale are organized institutionally among units of local government, tribal organizations, community and regional Alaska Native Claims Settlement Act (ANCSA) profit corporations, regional nonprofit Native organizations, and various special-purpose agencies. Information contained on the Alaska Department of Community and Regional Affairs (ADCRA) 1992 Community/Borough Map is a primary reference for this discussion (State of Alaska, ADCRA, 1992).

(1) __Upper Cook Inlet and Kenai Peninsula__: The communities of the upper Cook Inlet and Kenai Peninsula are organized under the Kenai Peninsula Borough, a second-class borough incorporated in 1964. The borough includes most of the Kenai Peninsula as well as coastal lands on the west side of Cook Inlet. Seldovia incorporated as a first-class city in 1945, and Kenai incorporated as a home-rule city in 1960. Homer and Soldotna incorporated as first-class cities in the mid-1960's. Tyonek organized a tribal council for the community under the Indian Reorganization Act in the late 1930's; it remains today as the governing body for the community (Fall, Foster, and Stanek, 1984). Regional tribal organizations include the Cook Inlet Tribal Council and Chugachmiut, formerly known as The North Pacific Rim. Regional ANCSA corporations include Cook Inlet Region Inc. and Chugach Alaska Corporation.

(2) __Kodiak Island__: Kodiak Island communities are incorporated into the Kodiak Island Borough, formed in 1963 as a second-class borough. The borough also includes uninhabited coastal lands opposite the archipelago on Shelikof Strait. The City of Kodiak is a home-rule city, formed in 1940, whereas five of the nonroad-connected communities (except Karluk) incorporated as second-class cities in the late 1960's and mid-1970's. Tribal councils also exist in these communities. The Karluk tribal council was formed in 1939 and is recognized by the State of Alaska as the local government for the community (Cultural Dynamics, Inc., 1986a). The Kodiak Area Native Association provides regional tribal services to most of the Native communities. Koniag, Inc., is the regional ANCSA corporation for the communities on Kodiak Island.

(3) __Upper Alaska Peninsula__: The five communities located in the Chigniks area are part of the Lake and Peninsula Borough, formed in 1989 as a home-rule borough. Chignik is the only second-class city, having incorporated in 1983. A tribal council also exists in Chignik. The other communities are governed by traditional tribal councils. The communities also are served regionally by the Bristol Bay (ANCSA) Native Corporation and the Bristol Bay Native Association.

d. __Effects of the *Exxon Valdez* Oil Spill__: The communities of the southern Kenai Peninsula, including Nanwalek and Port Graham, experienced individual and institutional effects from the grounding and spill of the *Exxon Valdez*. Individuals were mobilized and outfitted to clean beaches, drive vessels, and perform the multitude of tasks required to place and maintain cleanup crews in the field. The spill and cleanup offered to some a new arena for pre-existing personal and political conflict, especially over the dispensation of money and contracts (Mason, no date). In the smaller communities, cleanup work produced a redistribution of resources so that the haves and have-nots were different than before, creating new schisms in the community (Richards, no date). Many members of small communities were on the road to sobriety prior to the spill, but after the spill some people began drinking again, producing the re-emergence of the numerous alcohol-related problems that were there before, such as child abuse, domestic violence, and accidents (Richards, no date). An increase in drug and alcohol abuse, domestic violence, and crime were felt by some to be either already present or forthcoming because of the spill (Mason, no date).

Institutional effects included additional burdens being placed on local government, disruption of existing community plans and programs, strain on local officials, difficulties dealing with the spiller, community conflict, disruptions to customary habits and patterns of behavior, emotional effects and stress-related disorders, confronting environmental degradation and death, and violation of community values (Endter-Wada, 1992). According to Smythe (1990), one of the principal effects of the spill was the postspill loss of control over their environment by residents of the local communities. This loss of control, represented with communities being engulfed by the imperatives of spill-cleanup and -recovery procedures established by outsiders, was a major source of new stresses in communities (Smythe, 1990). Postspill-recurrent stress also resulted from secondary episodes, such as litigation, which produced secrecy over information, uncertainty over outcomes, and community segmentation (Picou and Gill, 1993). Attempts to mitigate effects met with a higher priority placed on concerns over litigation, and a reluctance to intervene with people for fear it might benefit adversaries in legal battles (Richards, no date).

(1) __Effects of the EVOS on Nanwalek and Port Graham:__ Research sponsored by MMS into the effects of the EVOS, which spanned 3 years, recently has been published and is the sole citation for this brief discussion (Fall and Utermohle, 1995). Nanwalek and Port Graham are among the communities investigated and are highlighted here because of the impact findings contained in Section IV.

The MMS-sponsored research contained questions that are divided into three topical areas: respondents' perception of food safety; respondents' assessments of their participation in subsistence and community activities; and respondents' predictions of the future conditions of the natural and human environment.

Clearly, issues of food contamination were of primary concern in many communities and were no less so in Nanwalek and Port Graham. Regarding food safety, respondents were asked whether they thought they were adequately informed about the safety of eating wild foods after the oil spill. Nearly two-thirds of the Nanwalek households and half the respondents in Port Graham responded positively in the first study year. In the following 2 study years, positive responses declined in both communities, although the Oil Spill Health Task Force made concerted efforts to address concerns about food safety by providing bulletins with findings on food-testing projects.

To further understand community concerns about foods safety, questions were asked about resources that were key elements of subsistence harvests. Respondents were asked whether clams and seals were safe for children to eat. The majority of respondents in Nanwalek felt throughout the 3 study years that clams and seals were safe to eat. Although responses to questions about seal edibility demonstrated a slightly diminishing but continuing concern for safety, responses to questions about the edibility of clams showed a heightened degree of concern. The majority of respondents in Port Graham throughout the 3 study years felt that seals were safe to eat. Responses to questions of clam and seal edibility demonstrated a slightly diminishing concern for safety.

The second category of questions measured current involvement in resource-use activities and satisfaction with community. Although there appeared to be increased dissatisfaction with living in Nanwalek and Port Graham over the 3 study years, well over 80 percent of respondents in each community liked living there either more or the same as before the spill. Relative to some other communities in the spill area, Nanwalek and Port Graham residents generally liked living where they did, and it would take something other than an oil spill to cause residents to move away.

Residents' participation in political activities may be another measure of their liking for the community. The majority of people (51.9% in Nanwalek and 59.1% in Port Graham) in both communities did not change their views of community leaders as a result of the spill. The vast majority of residents who responded in each community continued to be active in local and Statewide elections.

Participation in subsistence activities by children was dramatically affected by the EVOS, as reflected by over half of Nanwalek households that responded during all 3 study years. Opinions by Port Graham respondents about participation by children in subsistence activities were less pronounced than in Nanwalek, where a high percentage (87.5%) of adults worked on cleanup jobs in 1989; jobs that often kept workers away from the community for extended periods. In turn, children were not able to engage in their normal pattern of subsistence activities accompanied by their parents.

In another question measuring the likely effects of the spill, respondents were asked to compare current levels of sharing with levels before the spill. Two years following the spill found almost half (48.1%) of households in Nanwalek reporting less sharing than before the spill, while over half reported the same or more sharing. In Port Graham, one-third (32.6%) of households 2 years following the spill reported less sharing than before the spill, while almost 70.0 percent reported the same or more sharing. In the third year, almost 20 percent more households in Nanwalek reported less sharing than before the spill, as households mentioned greater independence in resource gathering through having more equipment to go out on their own. By the third year, an inexplicable decline of 27.2 percent of the households (40.7%) reported less sharing. A similar but less pronounced pattern of response occurred in Port Graham.

The last series of questions deals with the perspective respondents had relative to impacts that oil development might have on populations of wildlife and the human condition. Predictably, Nanwalek respondents echoed their concerns about offshore oil and gas development expressed during earlier inquires in the 1980's. As to how OCS development would affect wild resources, the majority of responses in both communities, especially so in Nanwalek, predicted lower populations of fish, marine invertebrates, marine mammals, and birds, especially waterfowl and marine birds. Port Graham respondents were somewhat less inclined to predict lowered land mammal populations; their responses were tempered with the knowledge that animals such as black bears and mountain goats use shorelines and intertidal areas in search of food during certain times of the year. Nanwalek residents mirrored Port Graham's responses about impacts to wildlife.

Nanwalek respondents' skepticism about impacts of OCS development carried over to their predictions about impacts on job availability. Fewer than half predicted more jobs would result from OCS development in the region. What is more, doubts about job availability increased throughout the 3-year study, and in the third year was the second highest of all study communities. On the question of job availability, Port Graham respondents held a somewhat more positive perspective about job prospects with just over half predicting more jobs as a result of OCS development.

5. **Archaeological and Cultural Resources:** During the past few years, a number of new historic and prehistoric resources have been discovered onshore near the proposed Sale 149 area. Ethnological data collected in the 1930's, excavations at Yukon Island and Cottonwood Creek in the 1920's, and the discovery of a possible Tanaina village in the 1880's in Kachemak Bay are indications of the other resources that may lie undiscovered on the land around the proposed lease-sale area. Following in this section is a discussion of the general locations and pertinent descriptions of what was found.

The descriptions in this section of historic and prehistoric archaeological resources are a summary of the research in Mobley et al., 1990. Also consulted were publications by Clark, 1975a; de Laguna, 1932; and two BLM papers on cultural resources (Tornfelt, 1981, 1982). Shipwreck material comes from Tornfelt and Burwell, 1992, shipwreck maps, and personal conferences and review by other knowledgeable individuals, including the MMS archaeologists and geophysicists. For a more detailed discussion of the potential for submerged prehistoric resources within the sale area, refer to Appendix F. The archaeological report lists the blocks that have high potential for prehistoric resources. The blocks are shown in Table III.C.5-1.

a. **Historic Resources (Present to 1741 A.D.):** There were brief contacts between Captain Cook (1778) and the Cook Inlet Natives. There also was the first known awareness that other cultures existed in the land surrounding the sale area when Vitus Bering "discovered" Alaska in 1741 at Kayak Island. The first sustained influence on the peoples of Cook Inlet, however, was when the Shelikov-Golikov Company established a post at Three Saints Bay on Kodiak Island in 1784. Historic resources left from that era are abundant. In addition, Native villages, canneries, a fish hatchery, iceworks, saltworks, fishing cabins, fox farms, cattle ranches, cemeteries, churches, and military installations are just a few examples of the historic resources that have been found and what may exist on Kodiak Island, the Kenai Peninsula, and Cook Inlet. There is a scarcity of archaeological records of the Russian Period for the Pacific coast of the Alaska Peninsula, although a number of 18th century village sites have been identified from historic writings and maps. Some survey data are available in the records of the State Historic Preservation Office.

Villages on and across from Kodiak Island yielded many resources. Kukak was one of these villages visited and described in 1813. In 1912, the eruption of Mt. Katmai (Novarupta) formed the Katmai National Park and motivated the abandonment forever of the early villages of Katmai, Kaguyak, Ashivik, Swikshak, Kukak, Sutkum, and other villages on the eastern side of the Alaska Peninsula. Relocation to the Chignik area seemed to be the choice of those early residents. Katmai is the most important of the known early historic sites located on the eastern coast of the upper Alaska Peninsula. It was a large, year-round Koniag village before the arrival of the Russians and continued to be the largest village during the times of Russian occupation. As a fortified trading post of the Russian American Company, Katmai was the community on the eastern coast where Russians lived permanently. The old village was nearly completely buried by ash after the 1912 eruption, and high-rising underground-water levels have since made research on Katmai very difficult.

The village of Kanatak was occupied for a short time in the 1930's by Natives of the area who worked in nearby oil-exploration activities. They left about 20 years later (Mobley et al., 1990). Other oil-exploration sites may be present elsewhere on the eastern coast. Cook Inlet coastal settlement in the upper Alaska Peninsula region has been slow, consisting mostly of small hunting and fishing cabins and canneries.

Seven volcanoes near the Sale 149 area have erupted in historic times (see Sec. III.A.1). Vessels wrecked prior to the eruption of Mt. Katmai in 1912 that may be lying on the seafloor in waters deeper than about 200 m might have acquired some additional protection from further disintegration as a result of sedimentation occurring in the area after the eruption. Since 1912, the thickness of sediments accumulating in some areas of the Cook Inlet region ranged from about 8 cm in the northeastern part of the strait to 84 cm in the central part (Hampton, 1985). The thickness of the sediments generally increases in a southwesterly direction from about 10 cm in the northeast to about 60 cm in the area opposite Uganik Bay (Kodiak Island)—a distance of about 100 km. The 1912 eruption deposited up to 3 m of ash on Kodiak Island, which lies to the east of the volcano. The amount of ash from the eruption that accumulated on the seafloor east of Katmai was up to 20 cm thick in places (Hampton, 1985). Hampton (1983) noted: "Although not subjected to testing the in situ density of ash is so great that normal gravity coring devices could not penetrate the layer. The relative density appears to be high and therefore the liquefaction potential is low."

The ash layer may provide some additional protection from further disintegration to the remains of wrecked vessels buried beneath it. The low liquefaction potential of the ash layer, as noted above, indicates it may be less susceptible to failure under cyclic-loading conditions than are the sediments in the overlying layer. The mean grain size of the surface sediments in the layer overlying the ash layer, in waters deeper than 200 m, ranges from about 0.06 mm to about 0.004 mm (Hampton, 1983); these sediments largely consist of mixtures of silt and clay-size particles (Hampton, 1985). (The diameter of silt-size particles ranges from 0.004 to 0.062 mm and that of clay-size particles ranges from 0.00024 to 0.004 mm.) The coarsest fragments in the basal part of the ash layer were a few millimeters in diameter (Hampton, 1985). In addition, the particles in the ash layer would be more angular than are the flat particles of the clay minerals and the rounded particles of other minerals such as quartz or feldspars. The larger, angular particles require more energy to initiate movement than do the smaller, flatter, or rounder particles and thus would be more resistant to erosion. The accumulation of fine-grained (silt- and clay-size particles) sediments in waters deeper than 200 m indicates the velocities of deep bottom currents are low (Roberts, 1993, personal comm.)

The earliest known shipwreck that might have been affected by a volcanic eruption in the sale area occurred in 1829. The approximate locations of small shipwreck groups in the sale area are shown in Figure III.C.5-1 and Table III.C.5-2 and listed in Tornfelt and Burwell (1992) and in the MMS computer program and maps. Of the 79 shipwrecks in Cook Inlet, 6 are in the Sale 149 area. There is not enough information on any of those 6 ships for them to be assigned to lease blocks. The other ships listed do not require archaeological review; however, they are listed because if found, each could be a hazard for drilling or become a source for small oil spills. The remaining ships (shown in Table III.C.5-2) are within the 3-mi limit or are outside the Sale 149 lease area. These "coastal" ships represent 92 percent of all the wrecks, and the offshore ships comprise 8 percent. The significance of these shipwrecks has not yet been fully assessed, and it is beyond the scope of this document to do so. However, for the purpose of this analysis, they all be will presumed to be historically significant.

b. <u>Prehistoric Resources (1741 A.D.[209 B.P.] to 7000 B.P.)</u>: Numerous known prehistoric sites exist around the proposed Sale 149 area (Fig. III.C.5-2). Some new sites were found in 1989 during the EVOS cleanup. These resources are discussed in the following geographical order: east coast of Alaska Peninsula resources, Kodiak resources, and Kachemak Bay and lower Cook Inlet resources. Within each of those geographical categories, resources are be discussed in a time (phase) sequence (Fig. III.C.5-3). The Prehistoric Resource Analysis (Appendix F and Table III.C.5-1) gives the blocks with a high probability for prehistoric archaeological resources.

(1) <u>Prehistoric Resources of the East Coast of the Alaska Peninsula</u>: Archaeologists generally agree that if one compares the discoveries on the east side of the Alaska Peninsula with the discoveries on the west side, it seems that the peninsula was a sort of boundary between the Pacific culture and the Bering Sea culture. However, there are few known sites for the Pacific coast of the Alaska Peninsula, and comparatively little research has been carried out there. The objective evidence for the time sequences comes from Kachemak Bay and from research by de Laguna (1934) and Clark (1975b).

<u>Resources from 500 to 1800 B.P., Mound, Beach, and Cottonwood Phases (Fig. III.C.5-3)</u>: That the Mound Phase is continuous with the phase farther back in time called the Beach Phase and the much earlier one called the Cottonwood Phase is suggested by many objects of the chipped-stone inventory. Almost all new hunting-weapon-point types, however, are very similar to those found in Katmai National Park at Brooks River Falls, indicating interior Norton culture (Norton culture is the culture found by Giddings at Cape Denbigh at Norton Sound, Alaska [Giddings, 1964]). Clark's (1977) Beach Phase sample included just under 900 stone and bone items and just under 200 ceramic pieces (Mobley et al., 1990).

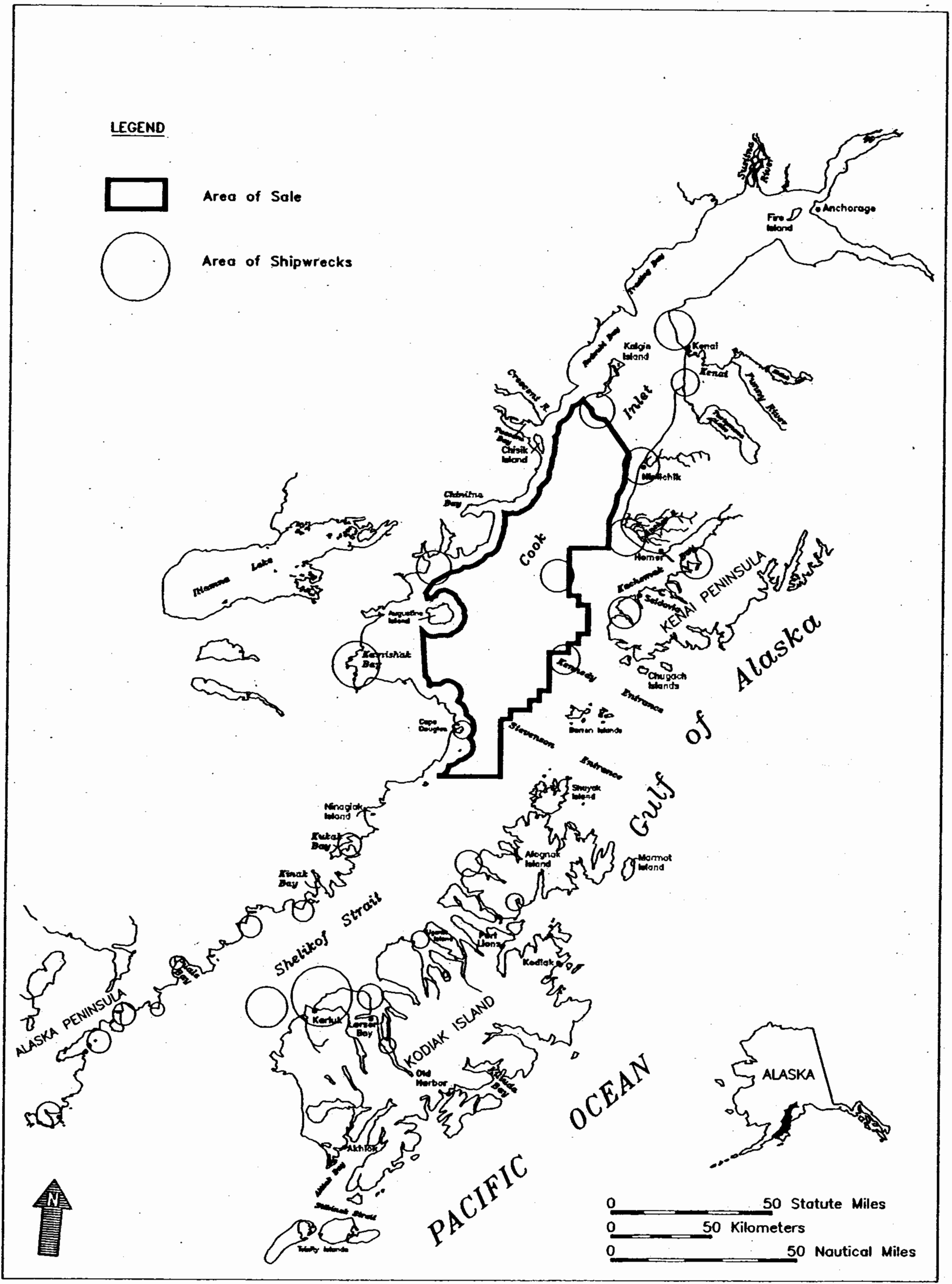


Figure III.C.5–1. Shipwreck Groups in the Lower Cook Inlet and Shelikof Strait Region.

Table III.C.5-2
Shipwrecks of the Cook Inlet and Shelikof Strait Region

Date of Wreck	Name of Wreck	Tons	Type	Location
1796	Tri Sviatitelia	Unknown	Russian vess.	Kamishak
1829	Karluk	Unknown	Russian vess.	Uganik Bay
1868	Torrent	Unknown	Bark	English Bay
1870/1871	Washington	Unknown	Bark	Kasilof
1881	Pauline Collins	69	Schooner	North Beach, Karluk
1886	Flying Scud	Unknown	Schooner	Near Karluk
1888	Julia Foard	Unknown	Bark	Cape Karluk
1890	Corea	564	Bark	South of Kalgin Island
1892	Elizabeth Mary	7	Steamer	Cook Inlet
1894	Alice	13	Schooner	Anchor Point
1895	Annie May	Unknown	Launch	Cape Karluk
1895	Raphael	1,465	Salmon ship	Karluk Harbor
1897	Therese	74	Schooner	Puale Bay
1898	Alton	84	Schooner	Mouth of Cook Inlet
1898	Anita	Unknown	Steamer	Cook Inlet
1898	Western Star	718	River steamer	Katmai Bay
1898	Unknown	Unknown	Sloop	Near Sunrise City
1899	Karluk	Unknown	Launch	Near Cape Karluk
1900	Merom	1,158	Bark	Karluk Harbor
1900	Wolcott	148	Steam schooner	West Southwest of Uyak Bay
1900	Emma and Louisa	Unknown	Schooner	Near Hope
1903	Delphine	Unknown	Launch	Karluk
1903	Nor'West	Unknown	Schooner	Near Port Wrangell
1907	Servia	1,886	Bark	Near Karluk Harbor
1909	Linea L.	13	Schooner	Portage Bay
1909	Uyak	22	Steamer	Wolcott Reef
1910	Arctic	Unknown	Unknown	Cape Douglas
1910	Farallon	749	Steamer	Black Reef, Iliamna Bay
1915	Bertha	926	Steamer	Harvester Island
1915	Susitna	Unknown	Gas screw	Kalgin Island
1915	Tyconda	Unknown	Stern wheeler	Anchorage
1915	Arnold	Unknown	Gas screw	Anchorage
1916	Kate Davenport	1,248	Bark	Anchor Point
1916	Bydarky	53	Barge	Bluff Point
1917	Kimback	Unknown	Motor vessel	Anchorage
1918	S. No. 2	54	Barge	Between Kodiak Is and Chignik
1920	Outline	Unknown	Gas screw	Cook Inlet
1920	Tinea	Unknown	Gas screw	Cook Inlet
1920	Valdez	Unknown	Gas screw	Portage Bay
1922	Grizzly	28	Gas screw	Jute Bay
1923	Agram	18	Gas screw	Near Chenik Bay
1923	Blazer	48	Gas screw	Southwest of Kanatak
1924	Balkom No. 8	63	Barge	Bluff Point
1924	Olaf	21	Gas screw	North of Kenai River
1925	Salmo	14	Gas screw	Kasilof River
1925	Alexander	13	Gas screw	Seldovia
1926	Sackett's Harbor	Unknown	Steamer	Off Anchorage
1927	Minneapolis	20	Gas screw	Halibut Cove
1927	Trio	28	Gas screw	Near Halibut Cove
1929	Aleutian	5,708	Steamer	Amook Island
1929	Golden Forest	5,658	Steamer	Cape Ilktugitak, Shelikof Strait
1929	Shamrock	13	Gas screw	South of Ninilchik
1930	Goget	29	Gas screw	Kukak Bay
1930	Owl	14	Gas screw	Wide Bay
1931	Delaware	32	Gas screw	North of Barren Islands
1931	Democrat	34	Gas screw	Iniskin Bay
1931	Mary C. Fisher	12	Gas screw	Cape Kabugakli
1931	Pilgrim	12	Gas screw	Malina Straits
1932	Discovery	Unknown	Gas schooner	Ninilchik
1932	Harriet G.	252	Brig/schooner	Uyak
1932	Libby, McNeil and Libby No. 9	14	Scow	Salamatof Beach
1932	Myrtle	9	Gas screw	South of East Foreland
1935	Libby, McNeil and Libby No. 2	28	Scow	East Foreland
1935	Salvator	467	Schooner	Seldovia Bay
1938	C.P. No. 12	Unknown	Scow	Kenai River
1938	San Marcos	Unknown	Gas screw	Seldovia
1942	Port Orford	1,293	Steamer	Barren Islands
1942	Unknown	Unknown		Kachemak Bay
1942	Unknown	Unknown		Redoubt Bay
1942	Deep Sea	Unknown	Diesel screw	Anchorage
1948	Kenai I	Unknown	Diesel screw	Mouth of Kasilof River
1952	Hercules	Unknown	Scow	Perl Island
1953	Ferry Queen	Unknown	Scow	Iliamna bay
1958	Mercury	Unknown	Diesel screw	Seldovia
1962	Ketovia	Unknown	Diesel screw	Cook Inlet
1965	Craig Foss	Unknown	Diesel Screw	Cook Inlet
1966	North Cape	Unknown	Barge	Near Anchorage

Source: Tornfelt and Burwell, 1992; Burwell, Shipwreck Computer Program, 1993.

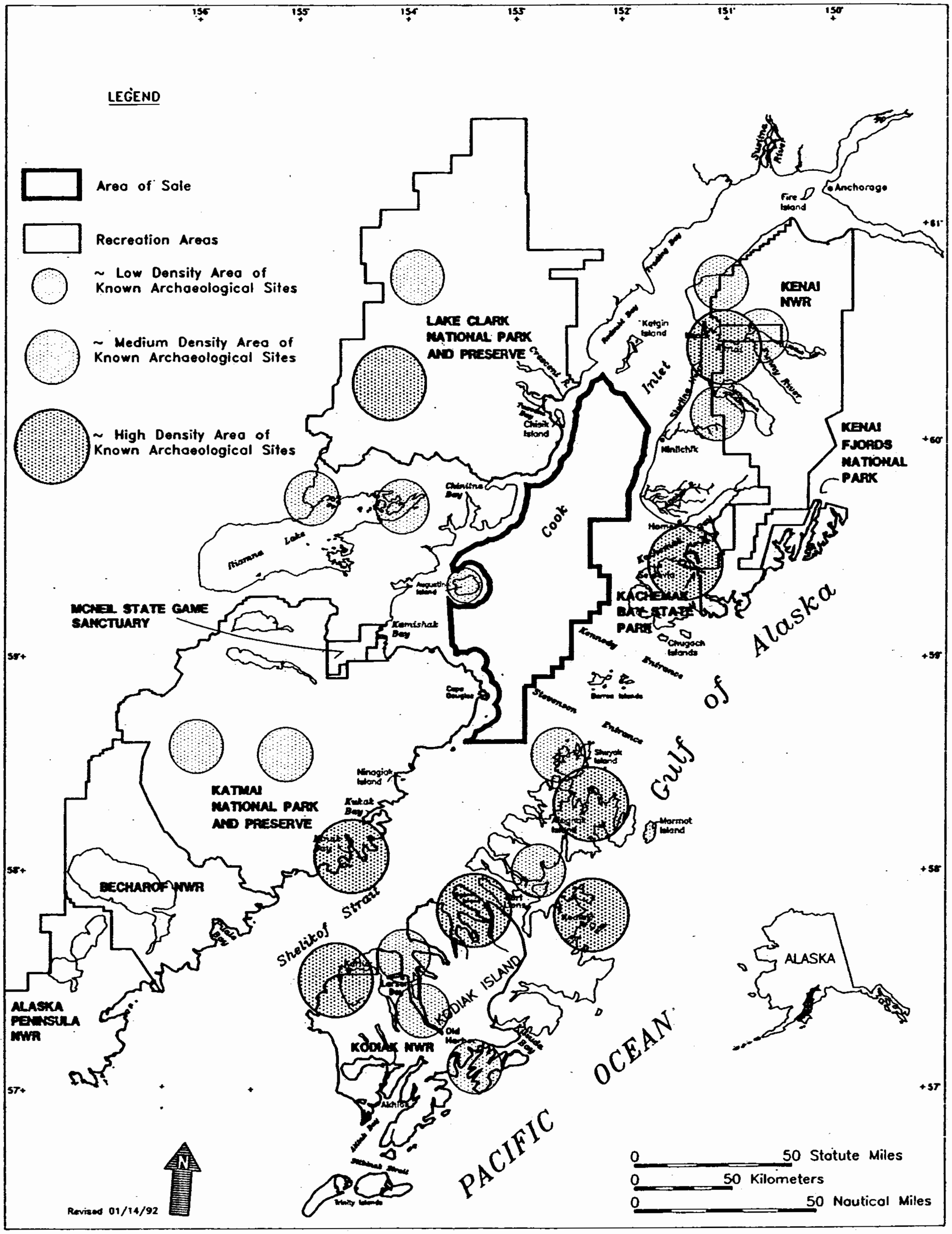
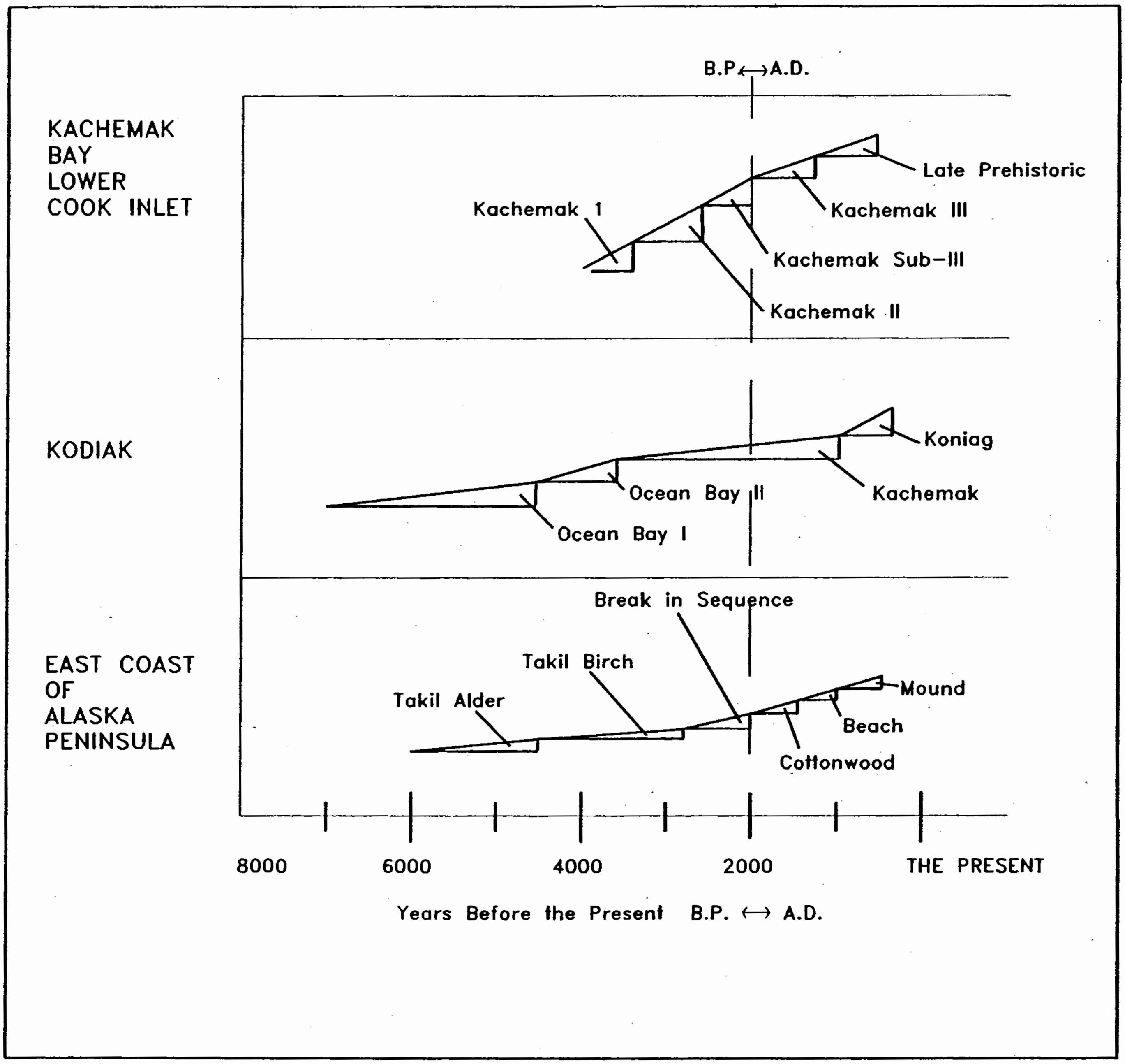


Figure III.C.5-2. Known Archaeological Sites in the Lower Cook Inlet and Shelikof Strait Region.



Sources: Clark, 1976; DeLaguna, 1934 and 1975; Crowell, 1992; and Ream, 1992.

Figure III.C.5-3. Cultural Chronology of the Lower Cook Inlet and Shelikof Strait.

An early view of coast-interior relationships on the Alaska Peninsula during the Beach Phase was stated in Dumond's (1977a) original synthesis of Alaska Peninsula prehistory, entitled *Eskimos and Aleuts, Archaeology of the Katmai Region*, which argues that because of the great similarity between the Brooks River Falls resources and the Pacific coast prehistoric resources, the people must have migrated across the peninsula. On the other hand, because Kodiak was not that similar to the other two resource sets, there is not an implication of migration to Kodiak (Mobley et al., 1990).

The resources around the proposed Sale 149 area indicate that this period was a time of an increasing flow of people and their culture from northern Norton Sound of Alaska to Kachemak Bay and vice versa. During the years 1500 to 1800 B.P. (Cottonwood Phase), few new types of projectiles are present, suggesting cultural continuity across the 1,000-year gap separating the Birch and Cottonwood Phases. Both chipped- and ground-stone implements in use before the time gap still remained in use in the Cottonwood Phase.

Pottery, another resource of this period, is undecorated and strengthened with vegetable fiber and sometimes includes gravel. The only vessel type found has a flat bottom with slightly flared sides. The Norton wares of the interior Alaska Peninsula groups are identical to this earliest of Pacific coast pottery. The Cottonwood Phase is of the same time period (1100-2000 B.P.) (Fig. III.C.5-3) as the earlier part of the late Kachemak (Three Saints Bay) phase on Kodiak and Kachemak III (1200-2000 B.P.) in Cook Inlet (Clark, 1966, 1970a, as cited in Mobley et al., 1990; and Clark, 1975a). Chipped-stone projectile types (probably arrow tips) found all the way through the Beach Phase, Cottonwood Phase, and Birch Phase time periods are a long-time signature of Alaska Peninsula Pacific cultures.

Resources from 2800 to 4500 B.P., Takli Birch Phase (Fig. III.C.5-3): No archaeological evidence has been found for the 1,000-year time period between the Cottonwood and Birch Phases. Chipped-stone tools are found comparatively less often in the Birch Phase. This change does not lower the number of types of chipped-stone tools, however, and almost all earlier Takli Alder Phase types continue into the more recent Birch Phase. Chipped-stone-type tools actually increase in the Birch Phase. Square-shouldered- and unshouldered-slate bayonets are more common in the early Birch Phase (Clark, 1977, as cited by Mobley et al., 1990). Ground-slate knives increase in frequency and types in the late Birch Phase; and labrets are found in the higher, more recent level of the Takli Site, indicating their late appearance (Clark, 1977, as cited by Mobley et al., 1990).

Resources from 4500 to 6000 B.P., Takli Alder Phase (Fig. III.C.5-3): Resources found at Clark's (1977) three Alder components (subparts of the Alder Phase) yielded under 800 stone and bone artifacts. The Mobley et al., 1990, report explains the absence of some types (such as pecked-stone oil lamps) in contemporary Kodiak sites or the later Birch Phase by using the small sample size as an explanatory tool. According to that report, the large number of chipped-stone objects and the absence of ground-slate tools are the defining characteristics of Alder components (Mobley et al., 1990).

Nearly the whole sample of the bifacial chipped-stone objects in the Takli Alder Phase are present in Clark's (1979) Ocean Bay I assemblages. When making comparisons between Takli Alder and Ocean Bay I period from the Kodiak Archipelago, the two time periods look similar enough to suggest close cultural ties and regular communication across the waters between Katmai area and Kodiak Island (Clark, 1984; Workman, Lobdell, and Workman, 1980). Among the variances is a minor slate-sawing and chipping industry on Kodiak, and edge-polishing of adzes on the Alaska Peninsula. The remains of microblade manufacturing in both areas suggest that possibly the connection between these cultures goes back to Paleoarctic times (Mobley et al., 1990). On the other hand, the objects from the Bristol Bay side are not so similar as the microblades on Kodiak and the Alaska Peninsula. They appear to be linked to the Alaskan Interior and coastal zone (Mobley et al., 1990).

For research purposes, the importance of these resources surrounding the Sale 149 area is seen when the papers of de Laguna (1934), Dumond (1969a,b; 1971), Clark (1975a,b; 1977; 1979), and others do not totally agree on the migration routes of the people whose culture they are researching.

(2) **Kodiak Archipelago Resources:** People have lived on the Kodiak Archipelago for about 7,000 years, as determined from the many archaeological resources recorded. Apparently, it was more heavily populated along the coast and along the rivers and streams, where there was an abundant source of fish and wildlife.

<u>Resources from 209 to 900 B.P., Koniag Phase (Fig. III.C.5-3)</u>: Compared to the Kachemak stone-tool artifacts, the Koniag inventory is less varied. Wood labrets were abundant, and stone lamps are rarely found in assemblages from this time period. The paucity of chipped-stone tools in the previous period continues into the Koniag period, and the intricate art of carving bone objects is found less often in this period. The "splitting adze" style appeared probably because the people built larger, many-roomed houses. The pottery also was heavier and undecorated (Heizer, 1948-9, as cited in Mobley et al., 1990). Barbed harpoons, armor rods, slats, and even shield parts are present in some of the assemblages collected by archaeologists, showing that there was the necessity for the inhabitants to defend themselves from others during this time period as well as during the historic period.

<u>Resources from 900-7000 B.P., Kachemak, Ocean Bay II, and Ocean Bay I Phases (Fig. III.C.5-3)</u>: There is a lack of any cultural remains for a period of about 1,400 years between the Koniag/Kachemak Phases. Despite this lack, Clark (1975) thought the small Old Kiavik (Kachemak) assemblage was different enough from Ocean Bay II that it was unlikely the earlier (Ocean Bay I Phase) was a continuation of the later (Koniag/Kachemak Phase). Some of the distinctions are that slate-tool grinding and drilling methods were replaced by percussion (striking) methods and there was more variation in finish, intricacies, and ornamentation. The Kachemak objects are more varied, with more attention to finish, detail, and ornament. The use of ground-slate implements is an objective signature that sets Kodiak apart from the Alaska Peninsula, where chipped-stone tools frequently were used during the Ocean Bay time periods (Mobley et al., 1990).

(3) <u>Kachemak Bay/Cook Inlet Resources</u>:

<u>Resources from 200 to 2000 B.P.</u>: During the Contact Period (the time when the European, English, and Russian people contacted the Native Alaskan people), other cultural traits were absorbed into the existing Native cultures; however, there was survival of traits and tools from the previous periods. Great changes in all of the Native cultures took place with the immigration of people from other cultures. Resources from this period reflect this change.

Ancestral Tanaina Athapaskans replaced Eskimo people (Workman, 1970). Abundant fire-cracked rock suggests the use of vapor-steam baths and suggests Tanaina and European relationships with Koniag occupations in the Kodiak Archipelago.

Kachemak III reveals a predominance of notched stones, stone lamps, stone hearths, semisubterranean houses, incised decorations, stone and shell beads, and other remains.

<u>Resources from 2000 to 3300+ B.P., Kachemak Sub-III, Kachemak II, and Kachemak I Phases</u>: The Kachemak Sub-III Phase is thought to be a transitional period between Kachemak II and III, marked by an increase in artifact types and numbers. Kachemak II is known from Yukon Island, Chugachik Island, and the Merrill Site (Mobley et al., 1990).

In the Kachemak II Phase, semisubterranean houses constructed of stone, wood, and whalebone suggest Norton culture influence. Some elements may correlate with part of the Old Kiavik phase on Kodiak. The earliest dates for these resources are from the Kenai Peninsula outside Kachemak Bay.

In Kachemak I, there was a preference for chipped-stone and other implements associated with the Norton culture (Mobley et al., 1990).

6. <u>National and State Parks and Related Recreational Places</u>: Generally, the coast in the proposed Sale 149 area and the marine environment offshore contain some of the most beautiful shore and ocean features in the world. The aesthetics of this are based on the near-pristine environment. Many people travel to this part of the State for just those features. The value of these resources is determined in part by these visitors. The major recreation and tourism resources for the proposed Sale 149 area are shown in Figure III.C.6-1. Important national parks, national wildlife refuges, national preserves, national monuments, national natural landmarks, and State of Alaska recreation areas, parks, and similar places exist near the proposed Sale 149 area. (Because of limited space in this text, only selected areas are described in some detail.)

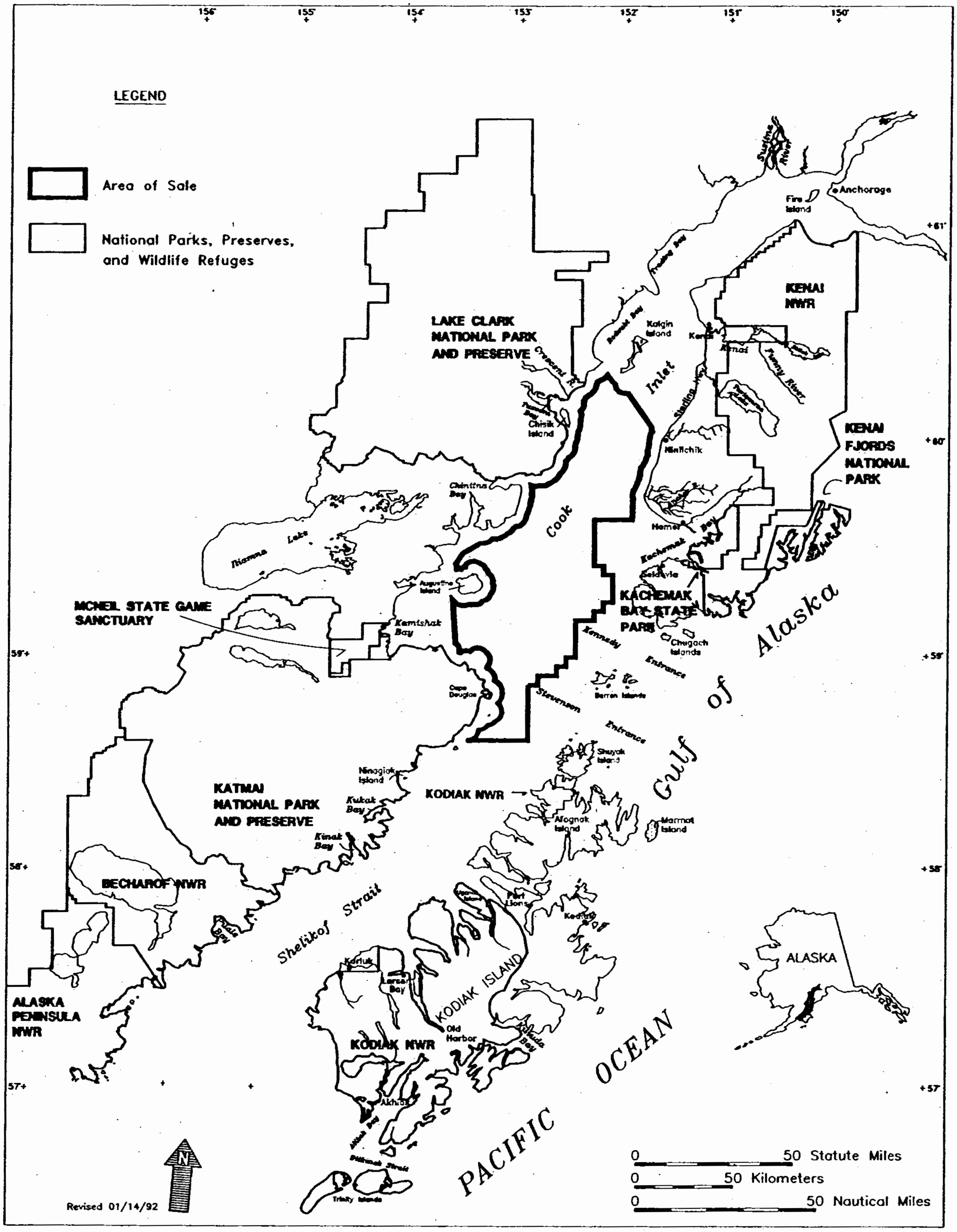


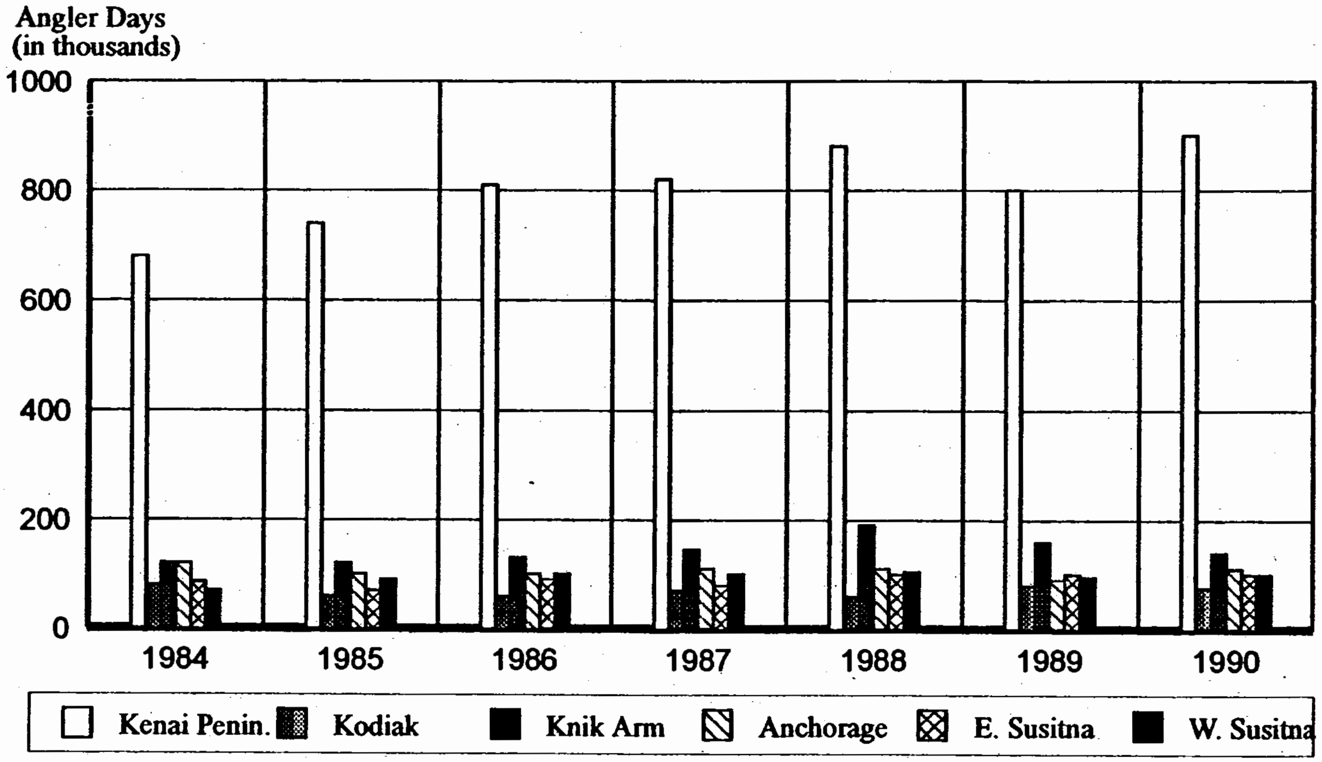
Figure III.C.6-1. National Parks, Preserves, and Wildlife Refuges of the Cook Inlet and Shelikof Strait Region.

On nearly every river, stream, or waterway, there is public access for fishing. In almost every State and Federal area surrounding the Sale 149 region, there is access and provision for hunting, swimming, skiing, camping, picnicking, and other numerous recreational pursuits. Such access is a resource to the recreationist and tourist. Some private lands provide for similar recreation and tourism activities. A sizable percent of the tourists and recreationists who visit these resources have licenses to fish (approximately 20%) and hunt (approximately 15%) (USDOI, National Park Service [NPS], 1992, personal comm.). Figure III.C.6-2 shows trends of recreational fishing in angler days (number of days fished per angler times the number of anglers). The Kenai Peninsula is used for fishing far more than either Kodiak streams, Knik Arm, Anchorage area streams, East Susitna River Drainage, or West Cook Inlet-West Susitna River drainage. Homer harbor reports 79 full-time local charter boats, plus a much larger number nonlocal or part-time vessels. Anchor Point and Ninilchik each report more than 100 vessels under charter on a full- or part-time basis. There is a growing charter fleet operation out of Kodiak. Also, an unknown number of private vessels are used for recreational fishing in the area, probably in the hundreds (see Sec. V, Comment). The sport-fish saltwater catch for the Kenai Peninsula area, excluding Seward, for 1993 is 448,197 fish and 963,054 razor clams. The sport-fish saltwater catch for the Kodiak area for 1993 is 100,793 and 1,286 razor clams (State of Alaska, ADF&G,, 1994).

a. **National Resources**: The following brief discussion of national parks, preserves, monuments, natural landmarks, and refuges describes some of the largest and most important resources related to tourism and recreation in the Sale 149 area.

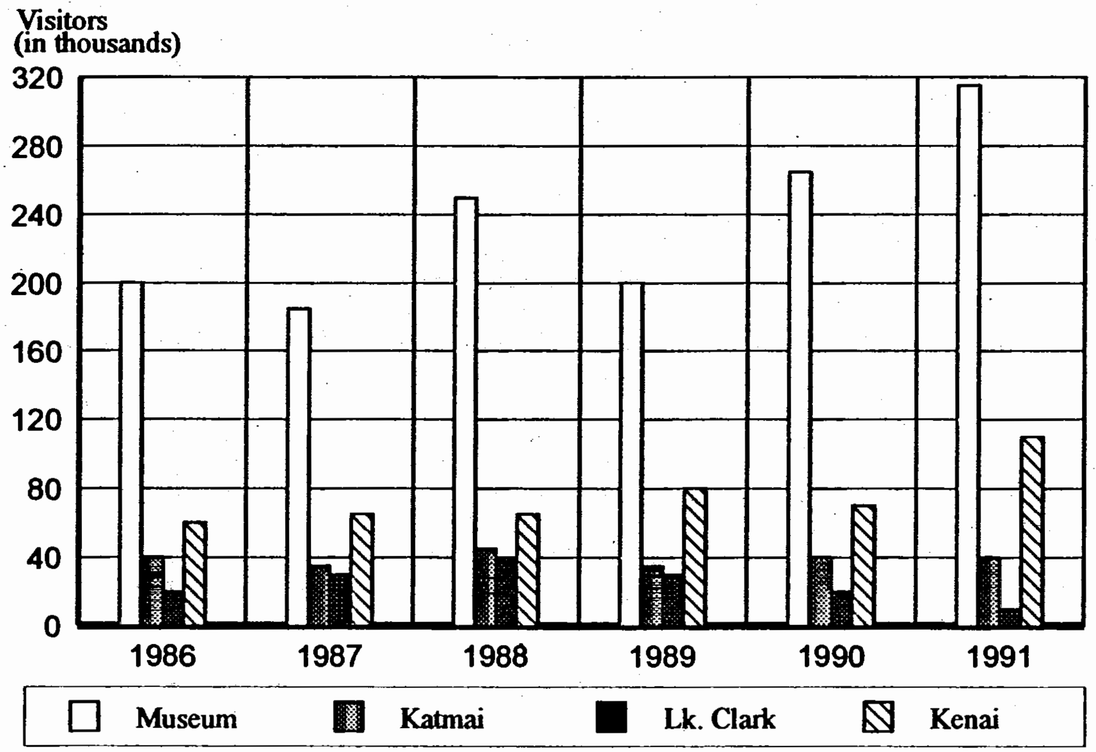
(1) **Katmai National Park and Preserve**: The character of this park, 4,093,240 acres in size, was created by the Mt. Katmai (Novarupta) eruption in 1912. It was not made a national park until all the other parks were created and finalized in the 1980's. All of the coast of Katmai National Park is designated wilderness. It is a testimony to the power of nature to form a variety of scenes and geological changes with the eruption of a volcano. A huge mountain was transformed into a much lower terrain. Oil from the EVOS (11.5 MMbbl spilled) of March 24, 1989, reached Katmai on April 30, about 33 days later. Some of the oil settled along beaches from Shaw Island on the north to Wide Beach on the south. On about April 29, there was an oil sheen 22 mi long and 10 mi wide. A fairly continuous slick of mousse and sheen—which was discovered from Hallo Bay to Katmai Bay, roughly about 50 mi—contacted shore at Katmai Bay and Hallo Bay and all along the headlands. Reports were that it had been found in Wide Bay, a distance of about 200 mi along the Alaska Peninsula. Oil was reportedly found on heavy cobble beaches under rocks that weigh over a ton (Anchorage Daily News, 1989). Today, industry reports beaches have been cleaned by natural environmental action. This claim is not entirely agreed on by the State researchers, who say some oil remains. The NPS states that subsurface *Exxon Valdez* oil has been documented. As of 1995, oil exists in great quantities under a thin cap of tar and asphalt. Foot traffic and exposure to water produce a sheen (USDOI, NPS, 1995). The legislation establishing Katmai National Park and Preserve (Public Law 96-487) states it shall be "managed for the following purposes, among others: To protect habitats for, and populations of, fish and wildlife including, but not limited to, high concentrations of brown/grizzly bears and their denning areas; to maintain unimpaired water habitat for significant salmon populations; and to protect scenic, geological, cultural and recreational features." The nationally significant values, which could be impacted by the Proposal, are described in the appropriate subsections of Chapter III, and analyses of impacts are in the appropriate subsections of Chapter IV. For example, brown bears are described in Chapter III.B.6 and potential impacts on brown bears are analyzed in Section IV.B.1.g.

(2) **Lake Clark National Park and Preserve**: This national park (Fig. III.C.6-1) encompasses over 4,440,130 acres. A portion of the coast at Lake Clark National Park, Chinitna Bay, is designated wilderness. The park includes the glaciated mountain terrain in the extreme northern portion of the park on the divide between the Kuskokwim, Skwentna, and Chilligan Rivers. Portions of the Stony, Telaquana, Mulchatna, Chilikadrotna, Little Mulchatna, and Kijik Rivers—which generally include open, rolling, tundra-covered foothills with spruce/birch forests along the major stream courses—also are in the park land. Included are two isolated forested lands west of Lake Clark, one near the Chulitna River and the other northwest of Hoknede Mountain. Most of the tundra and forest land within the Lower and Upper Tazimina Lake drainages, the Black Peak area, the Crescent Lake area, portions on either side of the Crescent River drainage, and the majority of the coastal forested lands along Cook Inlet between Chinitna and Tuxedni Bays are primitive and ideally suited for backpacking. Much of the park provides habitat for caribou, wolves, moose, bears, birds, and fish. Dall sheep are found at higher elevations, particularly on the western side. Caribou migration routes run from the northern boundary of the park/preserve to the western boundary north and south of the Mulchatna River. Part of the Mulchatna caribou herd uses lands from north of the Mulchatna River to south of the Chilikadrotna River as



Source: Mills, 1991: State of Alaska, ADF&G, 1991.

Figure III.C.6-2. Recreational Fishing Trends in the Cook Inlet and Shelikof Strait Region 1984-1990.



Source: USDOI, NPS, 1992; Anchorage Museum of History and Art, 1992.

Figure III.C.6-3. Number of Visitors to the Anchorage Museum versus the Number of Visitors to Katmai, Lake Clark, and Kenai Fjords National Parks.

calving grounds and the area west of the southwest shore of Lake Clark as winter range. Brown/grizzly bears are abundant along the coastal streams of Cook Inlet, where salmon spawn from June through September. The coast also is an important migratory bird route (USDOI, NPS, 1992, personal comm.). The legislation establishing Lake Clark National Park and Preserve (Public Law 96-487) states they shall be "managed for the following purposes, among others: To protect the watershed necessary for perpetuation of the red salmon fishery in Bristol Bay; to maintain unimpaired the scenic beauty and quality of portions of the Alaska Range and the Aleutian Range, including active volcanoes, glaciers, wild rivers, lakes, waterfalls, and alpine meadows in their natural state; and to protect habitat for and populations of fish and wildlife including but not limited to caribou, Dall sheep, brown/grizzly bears, bald eagles, and peregrine falcons." The nationally significant values, which could be impacted by the Proposal, are described in the appropriate subsections of Chapter III and analyses of impacts are in the appropriate subsections of Chapter IV. For example, brown bears are described in Chapter III.B.6 and potential impacts on brown bears are analyzed in Section IV.B.1.g.

(3) **Kenai Fjords National Park:** This park is one of the smaller national parks. It comprises some 669,590 acres of terrain, much of which is inundated by the glacial ice of the Harding Icefield, one of the major glacial systems along the coast of southern Alaska. The Harding Icefield is a more-or-less flat or dome-shaped deposit of glacial ice whose surface is generally at an elevation of about 1,300 m (4,164 ft). Because numerous peaks reach higher elevations, the ice sheet is marked by many protruding peaks, or "nunataks." Several large valley glaciers drain the icefield along the eastern border of the park, forming low-elevation outwash plains and sea-level glacial endings. Marine mammals and marine and other birds are some of the outstanding resources accessible by boat from the eastern side of the Kenai Peninsula. This coastal area of the park is of considerable importance to coastal and marine vertebrates, including several species of seabirds, harbor seals, the Steller sea lion, and the sea otter. The wildlife of Pye and Chiswell Islands are resources at the south end that are viewed daily during the summer from boat tours staging from Seward (USDOI, NPS, 1992, personal comm.).

(4) **Kodiak National Wildlife Refuge:** This refuge, 1,656,212 acres in size, is a favorite place to photograph bears. There are abundant fish and wildlife resources. Subsistence occurs particularly around Karluk, Larsen Bay, Atkiok village, and Old Harbor. The Koniag Corporation has listed lands to be traded south of Uyak Bay. Brown bear habitats are in the hills around Larsen Bay, Karluk, and Old Harbor. This refuge encompasses about three-quarters of the southern and western part of Kodiak Island and an area around Foul Bay on Afognak Island and Bann Island.

(5) **Becharof National Wildlife Refuge:** This refuge (1,200,021 acres in size) lies at the southeast end of the Sale 149 area and traditionally has been a relatively important sport-fishing location. The Becharof Lake area is optimum habitat for brown bears and is used by a large number of bears on a year-round basis. The area also is outstanding moose habitat, and some of the largest moose ever recorded have been taken here. The area also is considered to be important wintering habitat for a portion of the Alaska Peninsula caribou herd. Caribou have been seen within the area during the summer as well. Becharof Lake itself, in the northern portion of the refuge, is a large body of freshwater with a surface elevation of only 3 to 4 m above sea level. The lake is connected to Bristol Bay by the meandering Egegik River and is very important in the lifecycle of the red, or sockeye, salmon, which spends a portion of its life in open lakes. The salmon runs in this general area are unmatched elsewhere in North America.

Like the nearby and larger Iliamna Lake, the basin of Becharof Lake is at least partly the result of the out- flow of piedmont glaciers from the mountainous areas of the Pacific shore of the Alaska Peninsula northward and westward across the lowlands. This glacial activity also has strongly affected the surrounding terrain, leaving a number of glacial geomorphic features that are rather unusual in Alaska, where few extensive low- lands were glaciated. This rather unusual substrate and geomorphology results in an exceptional group of vegetation communities.

Volcanic activity also occurs within the site. Mt. Peulik is a classic volcano. Gas rocks show signs of current volcanic activity, and various lava fields and maars occur along the southeastern shore of the lake. Most of the mountainous western portion of the site, however, is composed of older sedimentary rocks; here, the terrain is rugged and shows a variety of the erosional features normally associated with alpine glaciation.

The Eastern shore of the refuge supports several significant seabird colonies, and several large murre colonies are found in or near Puale Bay. The entire area is of significance for waterfowl; whistling swans breed in the western portion, and a wide variety of ducks and geese either nest within the site or use it heavily for migration and molting. The Puale Bay area of the refuge supports major sea lion haulout grounds and also is considered to be a high-density area for harbor seals. Sea otters also are found within the refuge, although not in large numbers.

(6) McNeil River National Natural Landmark: This national natural landmark also is a State game sanctuary and is described in the subsection immediately below under the heading "State Resources." This area is designated a national natural landmark because it is nationally significant and posesses "exceptional value or quality in illustrating or interpreting the natural heritage of our Nation," presents "a true, accurate, essentially unspoiled example of natural history," and is a "seasonal haven for concentrations of native animals, or a vantage point for observing concentrated populations." (*Federal Register*, 1973) Bears concentrate at McNeil River to feed on migrating salmon, which has become a world-wide attraction for tourists.

(7) Alaska Maritime National Wildlife Refuge, Gulf of Alaska Unit: This refuge has about 475,000 acres extending over 800 mi from Kodiak Island in southcentral Alaska to Forrester Island in southeastern Alaska. The western portion of the Gulf of Alaska Unit is shown in Figure 11 of a document by the Fish and Wildlife Service, which is incorporated by reference (USDOI, FWS, 1988). The refuge consists of numerous small islands, islets, rocks, reefs, and spires around Kodiak Island, offshore of the southern Kenai Peninsula, and offshore of the Alaska Peninsula and some sections of shoreline of Kodiak Island. Primary marine fishes occurring in the Gulf of Alaska Unit include walleye pollock, capelin, sand lance, herring, sablefish, halibut, salmon, and Pacific cod. Important shellfish include dungeness, king, and tanner crab and shrimp. Three islands on the refuge have salmon streams. About 2.5 million seabirds representing 23 species inhabit the Gulf of Alaska unit. Lagoons, bays, and coastal waters provide most of the waterfowl habitat on or adjacent ot this unit and are used primarily for wintering and staging areas. Common migrating and wintering ducks include black scoters, surf scoters, white-winged scoters, greater scaup, bufflehead, common goldeneye, and oldsquaw. Shore bird habitats generally are restricted by vertical seacliffs and abrupt shorelines along most of the unit. Bald eagles are commonly observed throughout the refuge. Other raptors on the refuge include rough-legged hawks, marsh hawks, short-eared owls and, on forested islands, probably great-horned owls. Forty-four species of songbirds have been reported in this unit. Steller sea lion rookeries and haul-out sites are located on several islands in the unit.

b. State Resources: The State resources related to tourism and recreation in the Sale 149 area include the McNeil River State Game Sanctuary and the more accessible Kenai River Special Management Area (which includes about 30 State recreation areas and historic sites). These and others are listed in Table III.C.6-1.

(1) McNeil River State Game Sanctuary: The McNeil River Valley is a broad area of generally rolling lowlands, although some of the hilltops near the periphery of the sanctuary reach elevations of 1,000 m, or more. The McNeil River drains a number of lakes in the interior of the Alaska Peninsula and reaches lower Cook Inlet at the head of Kamishak Bay. The river is comparatively broad, shallow, and slow moving. It traverses a number of low, shallow falls. This, coupled with the fact that it provides access to interior lakes for anadromous fish, makes it an outstanding salmon river. Thus, it is an ideal river for brown bears to take advantage of the salmon runs, and the area probably has the highest concentration of brown bears in Alaska during the annual salmon run. Part of the sanctuary also is a known denning area for brown bears. The vegetation of the sanctuary is mainly tall brush along the lower reaches of the river valley, with stands of cottonwood also occurring. The uplands are dominated by heath and alpine meadow with some alpine tundra at higher elevations.

(2) Captain Cook State Recreation Area: The Captain Cook State Recreation Area (3,620 acres) is located at the end of Kenai Spur Road (Fig. III.C.6-1). Access to the area is available from mile 27.5 on the North Kenai Road, about 22 mi northeast of Kenai. The recreation area encompasses forests, lakes, rivers, and saltwater beaches; offers swimming and canoe landing; and is the terminal point for the Swanson River canoe trails, picnic areas, and camping. Sport fishing is available all year. Moose, bald eagles, waterfowl, and bears are commonly seen in the park. On the coast, the offshore oil rigs in Cook Inlet can be seen with the Alaska Range in the background. Rock hounds, beachcombers, and driftwood collectors are attracted to the beaches. Sanitary facilities and water are available.

(3) Ninilchik State Recreation Area: The Ninilchik State Recreation Area (97.35 acres) is located at mile 135 on the Sterling Highway, about 38 mi north of Homer (Fig. III.C.6-1). This recreation site offers excellent sightseeing. Mt. Redoubt lies directly across Cook Inlet from Ninilchik. A Russian Orthodox Church built in 1900 overlooks the picturesque Ninilchik village and can be viewed from the site. The site also

Table III.C.6-1
State of Alaska Recreation and Tourism Areas
Near the Proposed Sale 149 Area

Item	Area	Location (Mile and Highway)	Item	Area	Location (Mile and Highway)
Kenai River Special Management Area					
1	Captain Cook SRA[1]	End of Kenai Spur Rd.	17	Ciechanski	Ciechanski Rd.
2	Ninilchik SRA	135 Sterling Hwy .	18	Kenai River Flats	Kalifonski Beach Rd.
3	Deep Creek SRA	138 Sterling Hwy.	19	Caines Head SRA	Access by boat
4	Stariski SRA	151 Sterling Hwy.	20	Bernic Lake SRS	23 Kenai Spur Rd.
5	Silver King SRA	157 Sterling Hwy.	21	Bishop Creek	36 Kenai Spur Rd.
6	Kachemak Bay SP/WP	Access by plane or boat	22	Stormy Lake Swim Beach	36 Kenai Spur Rd.
7	Kenai Keys	78 Sterling Hwy.	23	Stormy Lake Picnic and Boat Launch	36.5 Kenai Spur Rd.
8	Bings Landing	79 Sterling Hwy.	24	Swanson River Landing	38.5 Kenai Spur Rd.
9	Izaak Walton	81 Sterling Hwy.	25	Discovery Picnic Area	39 Kenai Spur Rd.
10	Morgans Landing	85 Sterling Hwy.	26	Crooked Creek SRS	Coho Loop Rd.
11	Scout Lake	85 Sterling Hwy.	27	Kasilof River SRS	1005 Sterling Hwy.
12	Funny River	10 Funny River Rd.	28	Johnson Lake SRA	110 Sterling Hwy.
13	Nilmunga SHS	Funny River Rd.	29	Clam Gulch SRA	117 Sterling Hwy.
14	Kenai River Islands	River Miles 11-41	30	Anchor River SRA	157 Sterling Hwy.
15	Slikok Creek	Kalifonski River Rd.	31	Anchor River SRS	162 Sterling Hwy.
16	Big Eddy	Big Eddy Rd.			
Kodiak Area					
1	Ft. Abercrombie SHP	40 Rezanof Dr.	4	Shuyak Island SP	Access by plane or boat
2	Pasagshak SRS	40 Pasagshak River Rd.	5	Afognak Island SP	Access by plane or boat
3	Buskin River SRS	45 W Rezanof Dr.			

Source: State of Alaska, DNR, 1992.

[1] SP, State Park; SRS, State Recreation Site; SRA, State Recreation Area; SHP, State Historic Park; SHS, State Historic Site; ST, State Trail; WP, Wilderness Park; SMP, State Marine Park; P, Preserve.

Table III.C.6-2
Survey of Native Corporations on the Potential for Recreation and Tourism

Region	Location	Potential	Attitude
Chugach	Includes four communities in the Prince William Sound and lower Kenai Peninsula	Moderate to Good	The majority of the residents are very receptive to tourism development. There is some concern over local control, and at least one village currently is not interested in tourism development.
Cook Inlet	Includes two communities--Tyonek on the west side of the inlet and Hope on the south side of Turnagain Arm	Fair	Overall, the reception is positive. These communities already are experimenting with different types of visitor programs. But many Tyonek residents migrate to fish camps during summer, which creates a labor shortage.
Koniag	Six communities on Kodiak Island	Moderate to Good	All the villages welcome visitors, and several already are developing tourism opportunities.

Source: State of Alaska, Div. of Tourism, and the Community Enterprise Development Corporation, 1992.

offers good clamming and both commercial and sport fishing for salmon and halibut. Water and sanitary facilities are provided.

(4) Deep Creek State Recreation Area: The Deep Creek State Recreation Area is located at mile 138 on the Sterling Highway. This recreation site offers excellent fishing for salmon and halibut, and digging for razor clams and beachcombing are prime attractions. Coal washed up on the beach is used for fuel by local residents and visitors. A boat-launching facility for small crafts is available and sanitary facilities are provided, but no drinking water is available.

(5) Stariski State Recreation Area: Stariski State Recreation Area (30.05 acres) is located at mile 151 on the Sterling Highway, 20 mi north of Homer (Fig. III.C.6-1). This recreation site is on a high bluff overlooking Cook Inlet. The view of the Aleutian Chain is outstanding, and beluga whales are frequently seen in the inlet. High spruce trees provide privacy in the campground. Sanitary facilities and water are available.

(6) Silver King State Recreation Area: Silver King State Recreation Area is located at mile 157 on the Sterling Highway in the vicinity of Anchor point (15 mi northwest of Homer) (Fig. III.C.6-1). At the mouth of the Anchor River, this recreation area is a popular halibut and king and silver salmon fishing area, and steelhead trout are a primary attraction in the fall and winter. This site is one of the best areas in which to observe seaside and alpine floral vegetation. An abundance of birdlife and sealife, including whales, can be observed in this area. Sanitary facilities are provided; however, no drinking water is available.

(7) Kachemak Bay State Park and Wilderness Park: Kachemak Bay State Park and Wilderness Park is located 2 mi across the water southeast of Homer (Fig. III.C.6-1). Access is available from Homer by plane or boat. This undeveloped park contains 328,290 acres of wild mountainous terrain and magnificent ocean shoreline. Boating, beachcombing, fishing, and clamming are outstanding in the tree-lined bays, coves, and fjords; harbor seals and Eskimo and Indian house pits dating back 2,000 years may be seen on Chugachik Island; glaciers fed by the Harding Icefield spill down over the Kenai Mountains; and one can hike the marked, 3-mi-long trail from Glacier Spit to Grewing Glacier. Numerous unnamed glaciers exist in this wilderness area; and Kachemak Bay provides excellent fishing for halibut, salmon, shrimp, and dungeness and tanner crabs. Leisure Lake provides excellent rainbow trout fishing. Bears, wolves, goats, moose, and an abundance of birdlife can be seen in the park.

(8) Kodiak Area: In the Kodiak Area, Ft. Abercrombie State Historic Park (182,720 acres) is located at mile 4.0 on Rezanof Drive. Access is near Mill Bay Road about 3.5 mi north of Kodiak. Fort Abercrombie was a World War II military installation established in 1941 to defend the Naval Air Station on Kodiak Island. The park contains remnants of gun carriages, emplacement magazines, and other structures. Located on Miller Point on the northeasterly shore of Kodiak Island, Fort Abercrombie overlooks Mill Bay and Monashka Bay. It offers visitors spectacular views from steep rock cliffs and camping within densely wooded forests. It is the only developed State park on the island.

(9) Pasagshak State Recreation Site: Pasagshak State Recreation Site (20.136 acres) is located at mile 40 on the Pasagshak River Road. Access is available by a State-maintained gravel road near Pasagshak/Narrow Cape Road 40 mi south of Kodiak. Land along the Pasagshak riverfront is level, and vegetation is typical Kodiak grazing grassland. Upland portions rise abruptly into steep, low mountains. Views include the surrounding mountains, the Pasagshak River, and Pasagshak Bay. Its recreational value is primarily fishing. There are no developed camping or picnic facilities onsite.

(10) Critical Habitat Areas: There are four State critical habitat areas that potentially could be affected: Redoubt Bay, Kalgin Island, Clam Gulch, and Kachemak Bay. These each have critical habitat for various kinds of wildlife.

c. Visits by Tourists, Spending, and Employment in the Tourist Industry: An important part of the recreation resources available to tourists in the Anchorage area is the Anchorage Museum of History and Art. Visitors to the museum are a comparative indicator of yearly tourism to all recreational facilities on the Kenai Peninsula (Fig. III.C.6-3). Most visitors from outside Alaska also visit the museum while passing through Anchorage on their way to national parks. The Municipality of Anchorage and the museum keep records of visitors and a statistical record of visitor trends. Figure III.C.6-4 shows the trend of visitors with low years in 1987 and 1989 and high years in 1988 and 1991. Reflecting the seasonal variation of tourist visits to the State, the museum's highest visitor months usually are in the middle of the summer, and its lowest months are in the winter (Fig. III.C.6-4). The high visitor rates for October and November of 1988 and 1989 were due to the action-oriented displays of dinosaurs (1988) and whales (1989). About 30,000 school children visited those exhibits (Wolf, 1992.).

The value of these resources is partly shown by the number and time spent by tourists visiting these resources and by the amount of capital tourist expenditure in the surrounding communities. Native Corporation potential for recreational and tourism interests ia shown in Table III.C.6-2. Table III.C.6-3 shows only the available reliable expenditures by tourists according to the State of Alaska, Dept. of Labor (ADOL) (1991).

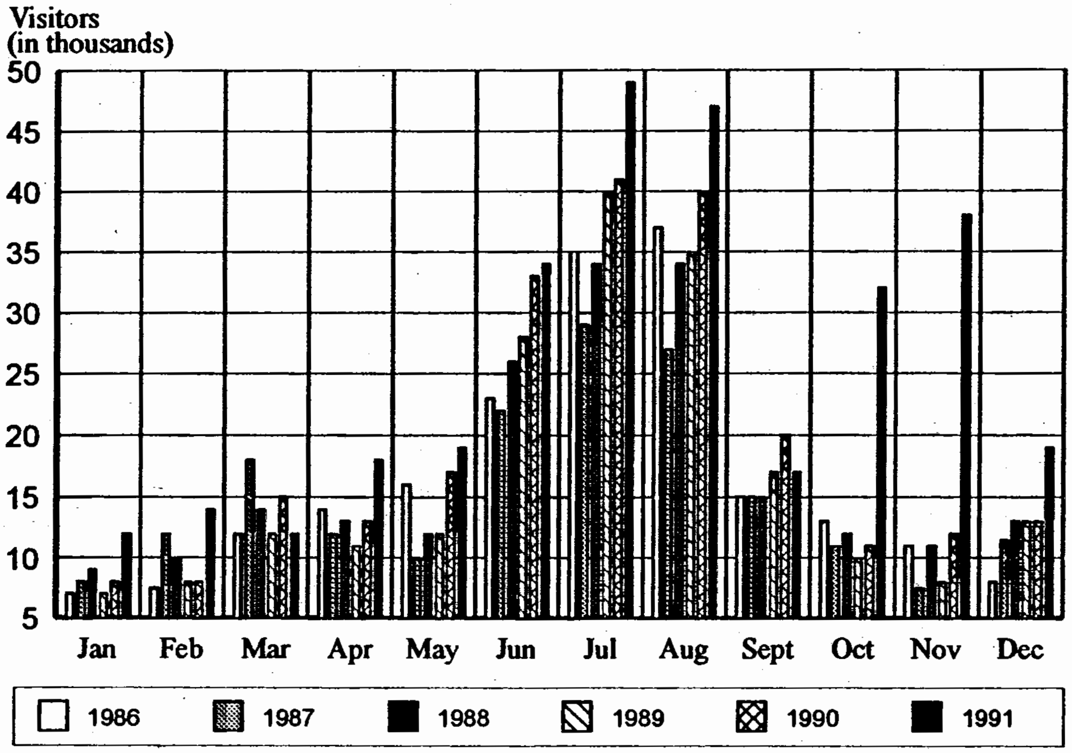
The Alaska Visitor Industry's report (State of Alaska, ADOL, 1991) identifies employment and financial information by referring to the areas near the proposed Sale 149 area as "Southcentral." The Southcentral region employment is dominated by the Anchorage economy but includes the Kenai Peninsula Borough, the Matanuska-Susitna Borough, and the eastern gulf coast. About 80 percent of the workers live in the Anchorage and Kenai Peninsula Boroughs. The oil industry is an important employer in the Anchorage area with approximately 5,200 workers, and another 1,000 workers are employed by the oil industry in the Kenai Peninsula area (State of Alaska, ADOL, 1991). The tourism industry employs an estimated 5,500 workers in the region, one in eight of the basic industry jobs in the region. This places the tourism industry second in terms of employment among the region's private-sector basic industries. The region's 355,000 pleasure visitors spent $122 million in 1989. Another $40 million was spent by visitors mixing business and pleasure while traveling in Southcentral Alaska. (For more detailed description of this area's economy, see Sec. III.C.1.)

Visitors to the national parks in and near the proposed lease-sale area primarily visited Katmai, Kenai Fjords, and Lake Clark National Parks. The number of visitors and the visitor hours are shown in Table III.C.6-4. Table III.C.6-5 shows the estimated number of visitors and visitor hours spent at Portage Glacier, the Anchorage Museum, and the Kenai River. Figure III.C.6-5 shows the number of visitors for the years 1982 through 1991; visitor-hour trends are shown in Figure III.C.6-6. From these figures, one can see that of the three parks, Katmai is by far the one most used, although the others have had from 10,000 to 320,000 visitor hours. A person visiting Katmai must take more time to do so because of the distance, the cost of getting and staying there, and the size of the park. The high peak of visitor hours in 1984, an anomaly, is due to either a high multiplier or a construction period where nonvisitor personnel building a viewing tower and replacing aging shelters were mixed with recreational visitors (USDOI, NPS, 1992, personal comm.). The Katmai National Park coast was "discovered" in 1989 by oil-spill response and -cleanup workers. Many of the oil-spill workers and contractors realized the potential for ecotourism on the Katmai shores after working there on the spill. Many returned in later years as ecotour providers and are the nucleus for a fast-growing industry. Exact figures are not available, but the best available estimates indicate the number of visitors to the Katmai coast tripled in the first 4 years after the oil spill. The NPS anticipates further increases in visitors because of television and magazine features on Alaskan brown bears and overloaded conditions at other popular bear-viewing locations in Alaska (USDOI, NPS, 1995).

7. Coastal Zone Management: The Federal Coastal Zone Management Act and the Alaska Coastal Management Act were enacted in 1972 and 1977, respectively. Through these acts, development and land use in coastal areas are managed to provide a balance between the use of coastal areas and the protection of valuable coastal resources. Local coastal districts can develop coastal management programs (CMP's) and tailor Statewide standards to reflect the local situations. These CMP's are incorporated into the Alaska Coastal Management Program (ACMP) after they are approved by the Alaska Coastal Policy Council (CPC) and the Secretary of the U.S. Department of Commerce through the Office of Ocean and Coastal Resource Management.

Both coastal districts adjacent to the lease-sale area have approved CMP's. These districts include the Kodiak Island Borough and the Kenai Peninsula Borough (Fig. III.C.7-1). The following paragraphs provide an overview of these district programs; specific enforceable policies of these district programs and the ACMP are included as appropriate in Section IV.

Kodiak Island Borough's CMP was fully incorporated into the ACMP in 1984. Activities that could affect fish and fishing resources and activities are carefully regulated through the Borough's CMP policies. In addition, the CMP contains policies that specifically address activities associated with oil and gas exploration and development (Kodiak



Source: Anchorage Museum of History and Art, 1992.

Figure III.C.6-4. Visitor Trends at the Anchorage Museum of History and Art, 1986-1991

Table III.C.6-3
Visitor Spending in Communities in 1991 Near the Proposed Sale 149 Area Fall/Winter/Spring/Summer

Community	Summer Expenditures (millions)	Fall/Winter/ Spring Expenditures (millions	Full Year Expenditures (millions)
Homer	5.7	2.1	7.8
Seward	4.2	0.8	5.0
Other Kenai	1.5	0.4	1.9
Wasilla	1.2	0.4	1.6
Palmer	1.0	0.4	1.4
Whittier	0.4	<0.1	0.4

Source: State of Alaska, DOL, 1991.

Table III.C.6-4
Visitors to National Parks Near the Proposed Sale 149 Area, 1990 to 1991

	Number of Visitors		Visitor Hours[1]
Park	1990	1991	1991
Katmai	40,778	41,417	539,688
Lake Clark	10,196	4,133	34,152
Kenai Fjords	69,764	107,973	323,919

Source: USDOI, NPS, 1991.

[1] These numbers are based on an estimated average time per visitor of 13 hours for Katmai, 8 hours for Lake Clark, and 3 hours for Kenai Fjords.

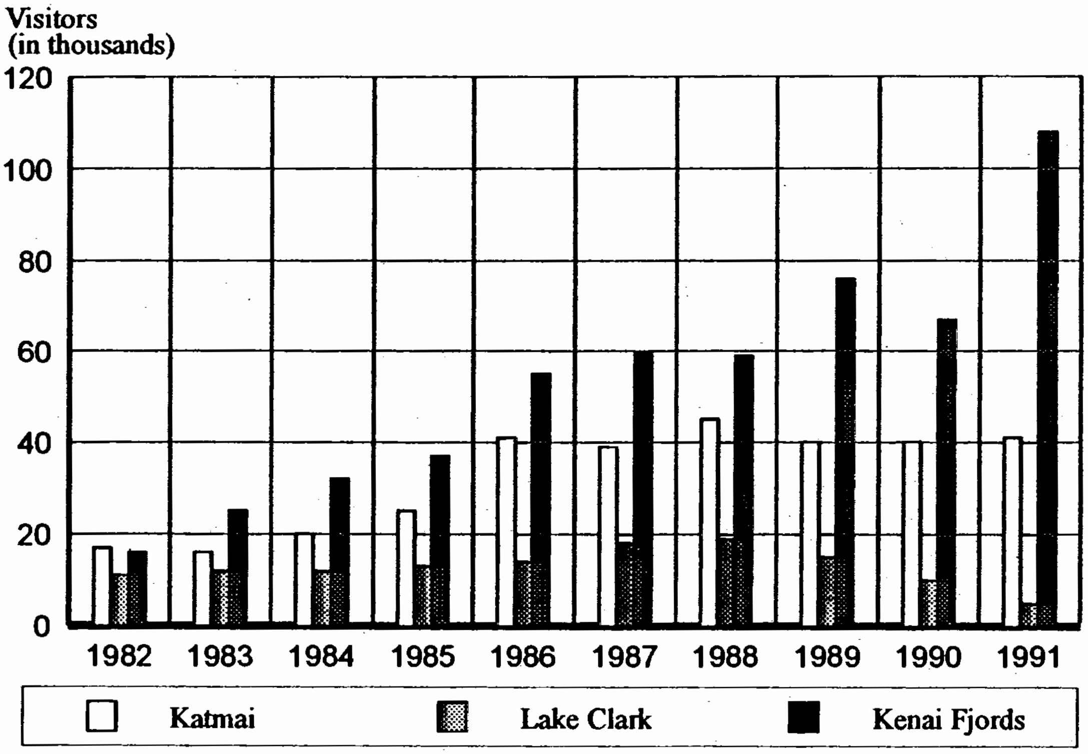
Table III.C.6-5
Number of Visitors at Major State Attractions Near the Proposed Sale 149 Area in 1991

Attraction	Number of Visitors	Visitors Hours[1]
Portage Glacier	301,500	904,500
Anchorage Museum	312,226	624,452
Kenai River	135,100	405,300[2]

Source: State of Alaska, ADOL, 1991.

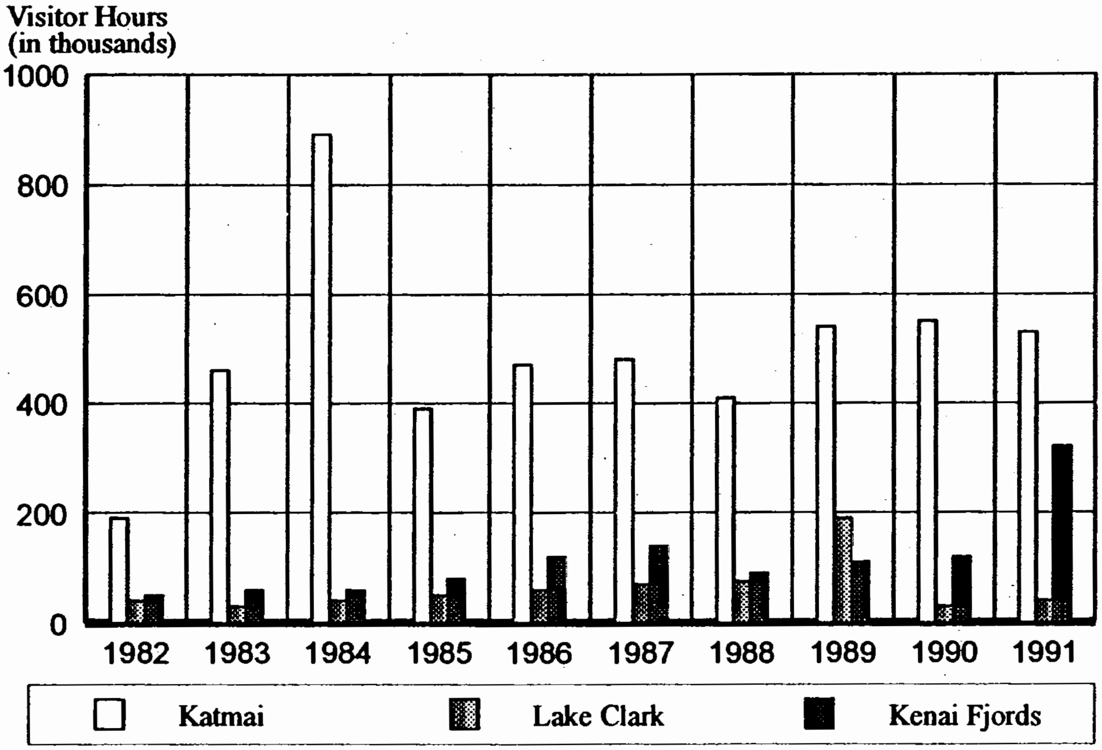
[1] These numbers are based on an estimated average visit time per visitor of 3 hours for Portage Glacier, 2 hours for the Anchorage Museum, and 3 hours for the Kenai River.

[2] This is estimated from the visitor-hour estimate of the Kenai Fjords National Park numbers.



Source: USDOI, NPS, 1992.

Figure III.C.6-5. Visitor Trends for Katmai, Lake Clark, and Kenai Fjords National Parks 1982-1991.



Source: USDOI, NPS, 1992.

Figure III.C.6-6. Visitor Hours at Katmai, Lake Clark, and Kenai Fjords National Parks 1922-1991.

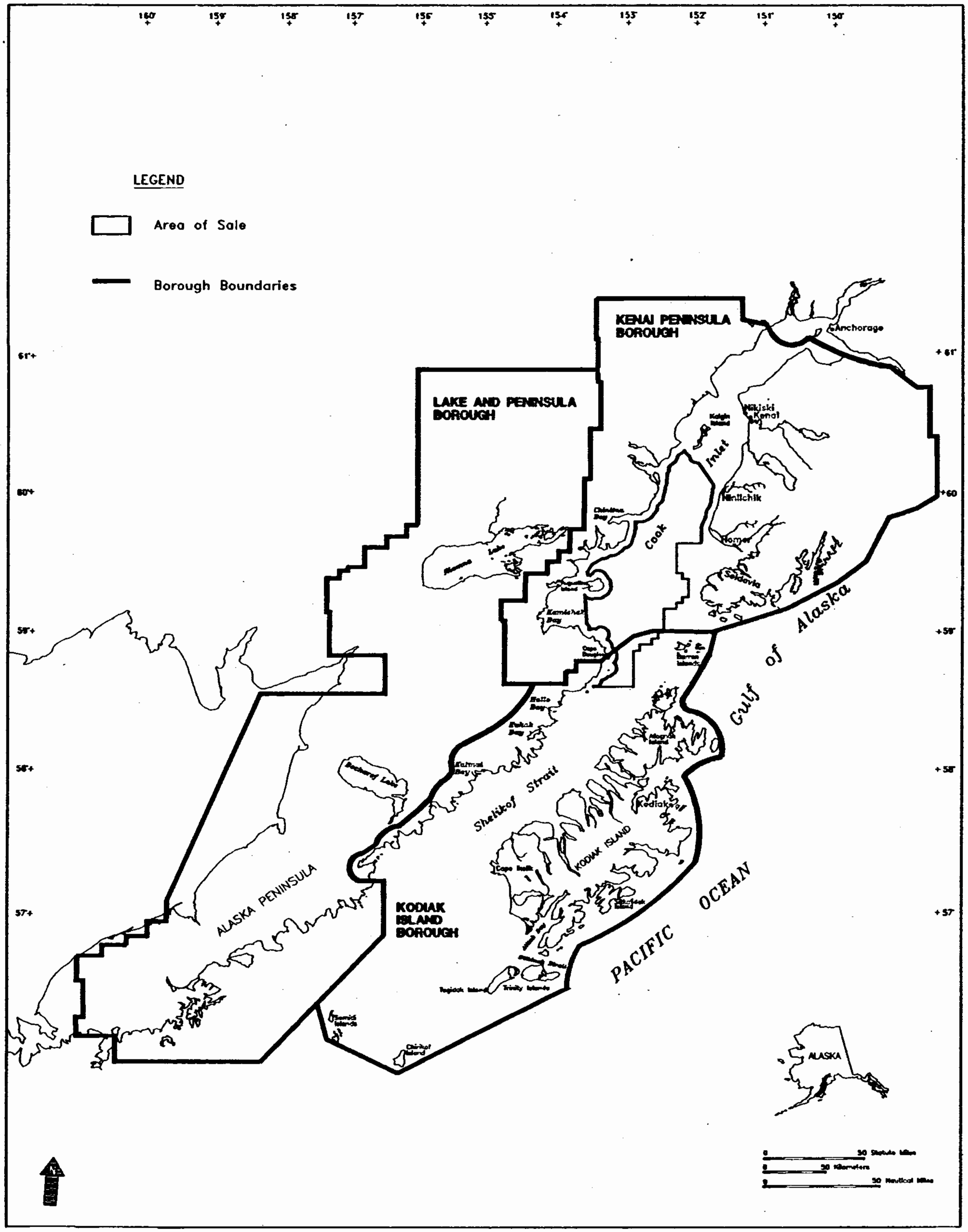


Figure III.C.7–1. Boundaries of Coastal Districts Adjacent to the Sale 149 Area.

Island Borough, 1984). The portion of the Bristol Bay Coastal Resource Service Area (CRSA) that abuts Shelikof Strait has been incorporated into the Kodiak Island Borough. Until the Kodiak Island Borough amends its CMP to include the western Shelikof area incorporated by the Kodiak Island Borough, the enforceable policies of the Bristol Bay CRSA CMP are the enforceable policies for that portion of the Shelikof coast. The Bristol Bay CRSA CMP policies emphasize the protection of fish resources and the fishing industry. They also augment the 16 Statewide standards for siting energy-facilities policies that are related directly to oil and gas development (Bristol Bay CRSA, 1987). The Kodiak Island Borough is revising its CMP to update its policies and to include the newly incorporated area. A Public Hearing Draft of the revised plan in expected in late fall 1995.

The Kenai Peninsula Borough CMP was fully incorporated into the ACMP in 1990. Boroughwide policies are general and not intended to create a substantial change from the existing Statewide standards. More detailed planning is anticipated to occur through the use of special plans for "Areas that Merit Special Attention" (AMSA's) (Kenai Peninsula Borough, 1990). The first of the AMSA plans, The Port Graham/Nanwalek AMSA, was approved by the CPC in October 1991 and incorporated into the ACMP in 1992.

D. **Oil and Gas Infrastructure**: The upper Cook Inlet and Kenai Peninsula have an association with the petroleum industry that dates back to the 1950's. The first discovery in the region took place onshore in 1957, when oil was discovered on the Kenai Peninsula from the Swanson River #1 well (Graphic 5). Except for the Beaver Creek Unit, which began producing oil in 1972, all other oil-producing fields are located in State waters. In 1993, Arco announced the discovery of a new commercially producible oil field. The new Sunfish field has not been fully delineated, and reserve estimates are still uncertain. The discovery wells are located approximately within the boundaries of the North Cook Inlet gas field (Graphic 5). At the height of oil production (1970), the Cook Inlet region produced 80 MMbbl; by 1983, production had declined to 24.7 MMbbl; and by 1991, production had declined to just over 15 MMbbl annually. Producible quantities of natural gas were first discovered in 1959 in what is now the Kenai Gas Field (Graphic 5). Gas production in the Cook Inlet region did not begin until 1960. By 1983, annual natural gas production had reached 196.4 billion cubic feet (Bcf); by 1992, production had fallen to approximately 125 Bcf.

At the peak of its infrastructure development, there were 15 offshore production and 3 onshore treatment facilities in upper Cook Inlet and approximately 230 mi of undersea pipelines (80 mi of oil pipeline, 150 mi of gas pipeline). These facilities are listed in Table III.A.5-9. Some of these facilities closed in 1992 as Cook Inlet production continuously declined (Table III.A.5-9).

How many new facilities the Sunfish discovery may create has not been determined. Existing Cook Inlet region production (off- as well as onshore) is handled through the Trading Bay production facility (Graphic 5), the Tesoro Refinery, the Phillips-Marathon LNG (liquefied natural gas) plant, and the Union Chemical plant. The last three facilities are located at Nikiski, Alaska, north of the city of Kenai. The Trading Bay facility pipelines its received crude-oil production to the Drift River Terminal. The Drift River Terminal stores and loads at least 9 MMbbl annually. Almost all of the Drift River crude is transported to Olium, California.

The Tesoro Refinery can process up to 80,000 bbl per day. Recent refinery production has been augmented by North Slope oil tankered from Valdez. Almost all Tesoro's output is consumed within Alaska. A products pipeline links the Nikiski refinery with the Tesoro fuel depot located at the Port of Anchorage. Tesoro's refined products include multigrades of gasoline, propane, Jet A, Diesel, No. 2 Diesel, JP4, and No.6 fuel oil.

The Phillips Marathon LNG plant was constructed in 1969 and liquefies 1 million tons of LNG annually. It is the United States' only natural gas liquefaction plant. Produced LNG is shipped by tanker to Japan (Tokyo Electric) by 80,000-m^3 carriers on an average of once every 10 days. Natural gas produced from the Kenai Gas Field is pipelined into Anchorage for domestic consumption; gas produced from the Beluga River field is used onsite at the Beluga River power plant (Graphic 5).

The Union Chemical company plant can process gas to produce more than 1.1 million tons of ammonia and a similar quantity of urea pills and granules (for fertilizer). Some of the produced urea is used in Alaska; the rest is shipped to the U.S. West Coast in tankers and bulk freighters. The reader is referred to Table IV-A-7 for additional information regarding oil and gas infrastructure in the affected area.

SECTION IV

ENVIRONMENTAL CONSEQUENCES

Section IV Table of Contents

IV. ENVIRONMENTAL CONSEQUENCES

IV. ENVIRONMENTAL CONSEQUENCES

A. Basic Assumptions for Effects Assessment:

1. Resource and Exploration and Development and Production and Transportation Assumptions: The potential effects of the proposed Cook Inlet Oil and Gas Lease Sale 149 are assessed in Section IV. This assessment includes the analysis of the effects of Alternative I (base, low, and high cases); Alternative II, No Sale; Alternative III, Delay the Sale; Alternative IV, the Wildlife Concentration Deferral; Alternative V, the Coastal Fisheries Deferral; Alternative VI, the Pollock-Spawning Area Deferral; Alternative VII, the General Fisheries Deferral; Alternative VIII, Northern Deferral Alternative; Alternative IX, Kennedy Entrance Deferral Alternative; and the cumulative case.

For the lower Cook Inlet sale area, the analysis contained within this section is based on assumed numbers for each of the alternatives; these assumed numbers lie within a range of resource estimates. The assumed resource numbers and scenario information for each of the alternatives are shown in Table IV.A.1-1; the relationship between scenario information based on the assumed resource estimates and the scenario information based on the estimated ranges is shown in Table IV.A.1-2.

a. Alternative I: For purposes of analysis, the number assumed for the low case of the proposed action is 40 million barrels (MMbbl), 200 MMbbl for the base case, and 800 MMbbl for the high case. The resources assumed for the low case are not commercial, and this case is considered exploration only. These assumed numbers are used to develop the exploration, development and production, and transportation scenarios used to analyze the potential effects of the proposed sale. In Alternative I, a total of 402 blocks are offered for sale (Sec. II.A).

The low case represents a minimum resource volume of hydrocarbons likely to be present. The analysis of the low case in Section IV.B.8 is based on the assumption that the volume of hydrocarbons likely to be present would be below the minimum economic resource required for development and production. Therefore, this analysis is based on a minimum amount of industrial activity that might occur in the Sale 149 area.

The base case represents a most likely amount of hydrocarbon resources that is assumed to be developed if commercial quantities of hydrocarbons are discovered. The base case includes (1) the undiscovered resources estimated to be leased, developed, and produced and (2) an estimate of the exploration, development and production, and transportation activities appropriate to that level of resources. The analysis of the base case in Section IV.B.1 represents the principal analyses of the effects of the proposed action—the presumed result if the proposed lease sale is held. The Oil Spill Risk Analysis (OSRA) model estimates a mean number of 0.31 spills greater than or equal to (≥) 1,000 barrels (bbl) are likely to occur as a result of the base-case scenario, with an estimated 27-percent chance of one or more such spills occurring. For the purposes of analysis, this EIS assumes one 50,000-bbl spill will occur.

The high case represents a maximum resource volume of hydrocarbons likely to be present in commercial quantities. The analysis of the high case in Section IV.B.9 includes estimates of (1) a higher level of resource recovery in comparison with the base case and (2) exploration, development and production, and transportation activities that might result from leasing more acreage than might occur for the base case or discovering and producing larger amounts of oil. The OSRA model estimates a mean number of 1.26 spills ≥1,000 bbl are likely to occur as a result of this scenario, with an estimated 72-percent chance of one or more such spills occurring. For the purposes of analysis, this EIS assumes one 50,000-bbl spill will occur.

b. Deferral Alternatives: The potential effects of a proposed sale based on alternative sale-area configurations are analyzed for six areal deferral alternatives:

(1) Alternative IV, Wildlife Concentration Deferral Alternative: The configuration for Alternative IV is based on the proposed deletion of 52 blocks (Sec. II.D). These block deletions are formed by two distinctive block groups. Alternative IV was designed to protect seabird colonies and other wildlife.

Table IV.A.I-1
Summary of Basic Exploration, Development and Production, and Transportaion Assumptions for Alternatives I, IV, V, VI, VII, VIII, and IX (Cook Inlet Oil and Gas Lease Sale 149)

EXPLORATION

	Alternative I						Alternative IV (Wildlife Concentration)		Alternative V (Coastal Fisheries)		Alternative VI (Pollock-Spawning Area)		Alternative VII (General Fisheries)		Alternative VIII (Northern)		Alternative IX (Kennedy Entrance)	
	Low Case		Base Case		High Case													
PHASE Activity/Event	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame
EXPLORATION																		
Well Drilling																		
		1997-1998		1997-1998		1997-1999		A		A		A		A		A.		A
Exploration Wells	3		3		11		3		2		3		2		2		3	
Delineation Wells	--		5		17		4		3		4				3		5	
Drilling Discharges																		
Drilling Muds[1] (Short Tons)	1,080		2,880		10,080		2,520		1,800		2,520		720		1,800		2,880	
Cuttings[1] (Short Tons)	1,320		3,520		12,320		3,080		2,200		3,080		880		2,200		3,520	
Support Activities																		
Helicopter Flights[2]	180-450		480-1,440		1,680-5,040		420-1,260		300-900		420-1,260		120-360		300-900		480-1,440	
Supply-Boat Trips[3]	90-270		240-720		840-2,520		210-630		150-540		210-630		60-180		150-540		240-720	
Shallow-Hazards Site Surveys																		
Total Area Covered[4] (mi^2)	26.7		71.2		249.2		62.3		44.5		62.3		17.8		44.5		71.2	
Total Number of Days Required[5]	6		16		56		14		10		14		4		10		16	

Table IV.A.1-1 (Continued)
Summary of Basic Exploration, Development and Production, and Transportaion Assumptions for Alternatives I, IV, V, VI, VII, VIII, and IX (Cook Inlet Oil and Gas Lease Sale 149)

DEVELOPMENT AND PRODUCTION

PHASE Activity/Event	Alternative I						Alternative IV (Wildlife Concentration)		Alternative V (Coastal Fisheries)		Alternative VI (Pollock-Spawning Area)		Alternative VII (General Fisheries)		Alternative VIII (Northern)		Alternative IX (Kennedy Entrance)	
	Low Case		Base Case		High Case													
	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame
DEVELOPMENT AND PRODUCTION																		
Platforms																		
Number			3		11		3		2		3				2		3	
Installation				1999-2001		2000-2003		A		A		A				A		A
Production- and Service-Well Drilling																		
Number of Wells			48	2000-2002	198	2000-2004	41	A	29	A	40	A			29	A	48	A
Production (Estimated Range)																		
Total (MMbbl)			200		800		160		140		150		(40)		140		200	
Peak Yearly (MMbbl)			17	2004-2008	67	2004-2008		A		A		A				A		A
Monthly Support Activities																		
Helicopter Flights[6]			60		180		60		40		60				40		60	
Supply-Boat Trips[7]			30-60		90-180		30-60		20-40		30-60				20-40		30-60	
Drilling Discharges																		
Drilling Muds[8] (Short tons)			3,840-17,760		15,840-73,260		3,280-15,170		2,320-10,730		3,200-14,800				2,320-10,730		3,840-17,760	
Cuttings[8] (Short tons)			26,880		110,880		22,960		16,240		22,400				16,240		26,880	
Shallow-Hazards Surveys																		
Total Area Covered[9] (mi²)			106.5		390.5		106.5		71		106.5				71		106.5	
Total Days Required[10]			21		77		21		14		21				14		21	

Table IV.A.1-1 (Concluded)
Summary of Basic Exploration, Development and Production, and Transportaion Assumptions for Alternatives I, IV, V, VI, VII, VIII, and IX (Cook Inlet Oil and Gas Lease Sale 149)

TRANSPORTATION

PHASE Activity/Event	Alternative I						Alternative IV (Wildlife Concentration)		Alternative V (Coastal Fisheries)		Alternative VI (Pollock-Spawning Area)		Alternative VII (General Fisheries)		Alternative VIII (Northern)		Alternative IX (Kennedy Entrance)	
	Low Case		Base Case		High Case													
	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame	Assumed Number or Value	Time-frame
TRANSPORTATION																		
Oil Pipelines																		
Installation				2002		2001-2002		A		A		A				A		A
Offshore Length (mi)			125		150		120		100		95				125		125	
OIL SPILLS -- See Tables IV.A.2-2 and IV.A.2-4																		

Source: Appendix A

A The timeframe is assumed to be similar to that for Alternative I (base case).

[1] Amounts are based on each exploration and delineation well using 360 tons (dry weight) of drilling muds and producing 440 tons (dry weight) of cuttings.

[2] The number of helicopter flights is based on the assumption that there will be 30 to 60 flights per month per well; drilling of an exploration or delineation well is estimated to take 2 to 3 months.

[3] The number of supply-boat trips is based on the assumption that there will be 15 to 30 trips per month per well; drilling of an exploration or delineation well is estimated to take 2 to 3 months.

[4] MMS's site-clearance seismic-survey requirements specify a minimum area of 23 km^2 (about 8.9 mi^2--an area that is about equal to one full OCS lease block) for a site-specific survey.

[5] The time required to comple a site-clearance survey is estimated to be 2 days.

[6] The number of monthly helicopter flights is a maximum number based on the assumption that there will be one flight per day per development/production wells. The number of flights displayed is a monthly average of yearly activity ; the number of flights is expected to decline after the drilling of the production and service wells.

[7] The number of supply-boat trips is a maximum number based on the assumption that supply boat trips to development/production wells (and associated rigs) will occur once every two days or once a day during drilling. The number of support boat trips is a monthly average of yearly activity ; the number of trips is expected to decline after the drilling of the production and service wells.

[8] Amounts are based on each production or service well using between 80 and 370 tons (dry weight) of drilling muds and producing 560 tons (dry weight) of cuttings.

[9] MMS's site-clearance seismic-survey requirements specify a minimum area of 92 km^2 (about 35.5 mi^2) for a blockwide survey.

[10] The time required to comple a site-clearance survey is estimated to be 7 days.

Table IV.A.1-2
Sale 149 Estimated and Assumed Scenario Information[1]

Alternatives	Exploration Wells		Delineation Wells		Exploration & Delineation Rigs/Year (Number of Years)	Production Platforms		Production and Service Wells		Production Rigs/Year (Number of Years)	Production (19 Years) (MMbbl)		Shore Bases		Offshore Pipelines (Miles)	
	Estimated Range	Assumed	Estimated Range	Assumed		Estimated Range	Assumed	Estimated Range	Assumed		Estimated Range	Assumed	Estimated	Assumed	Estimated (Nnumber of Years)	Assumed
I Proposal																
Base Case	1-5	3	3-8	5	1 (2)	2-5	3	24-84	48	1-2 (3)	100-300	200	1	1	75-150 (2)	125
Low Case[2]	3	3	--	--	1 (2)	--	--	--	--	--	--	--	1	1	--	--
High Case	8-20	11	12-24	17	1-2 (3)	8-20	11	122-360	198	1-6 (5)	550-1,100	800	1	1	150-200 (2)	150
IV Wildlife Concentration	1-4	3	2-6	4	1 (2)	2-4	3	24-67	41	1-2 (3)	80-240	160	1	1	75-140 (2)	120
V Coastal Fisheries	1-3	2	2-5	3	1 (2)	1-3	2	12-54	29	1-2 (3)	70-210	140	1	1	65-110 (2)	100
VI Pollock-Spawning Area	1-4	3	2-6	4	1 (2)	2-4	3	24-66	40	1-2 (3)	75-225	150	1	1	75-100 (2)	95
VII General Fisheries[2]	1-2	2	--	--	1	--	--	--	--	--	--	(80)[3]	1	1	--	--
VIII Northern	1-3	2	2-5	3	1 (2)	1-3	2	12-54	29	1-2 (3)	70-210	140	1	1	75-210 (2)	125
IX Kennedy Entrance	1-5	3	3-8	5	1 (2)	2-5	3	24-84	48	1-2 (3)	100-300	200	1	1	75-150 (2)	125

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[1] The estimated range of numbers will be used to develop the exploration, development and production, and transportation scenarios in Section II of the EIS, and the **assumed numbers** will be noted in Section IV.A.1 and are the values to be used to analyze in Section IV.B the potential effects of Sale 149.

[2] Alternative IV—Low Case and Alternative VI—General Fisheries are exploration-only scenarios.

[3] Resource Estimate—no production.

(2) <u>Alternative V, Coastal Fisheries Deferral Alternative</u>: The configuration for this alternative is based on the suggested deletion of 153 blocks located primarily around the perimeter of Cook Inlet (Sec. II.E). This alternative was designed to lessen effects on fisheries resources that might occur from oil spills.

(3) <u>Alternative VI, Pollock-Spawning Area Deferral Alternative</u>: The configuration for this alternative is based on the deletion of 42 blocks (Sec II.F). These block deletions are focused on protecting pollock-spawning areas.

(4) <u>Alternative VII, General Fisheries Deferral Alternative</u>: The configuration for this alternative is based on the deletion of 217 blocks (Sec. II.G). It would encompass the southern Shelikof Strait and most of the central portions of the lower Cook Inlet. This alternative is similar to Alternative V; however, it gives additional protection to fisheries areas.

(5) <u>Alternative VIII, Northern Deferral Alternative</u>: This alternative would offer for lease 285 blocks in that part of the Sale 149 area south of Anchor Point (Sec. II.H). The area removed by the deferral alternative consists of 117 whole or partial blocks located north of Anchor Point. The purpose of this alternative is to protect the fisheries resources of the northern part of lower Cook Inlet.

(6) <u>Alternative IX, Kennedy Entrance Deferral Alternative</u>: This alternative would offer for lease 385 blocks. The area removed by the deferral alternative consist of 17 blocks in two areas adjacent to Kennedy Entrance (Sec. II.I.1). One of the areas is off the southwestern end of the Kenai Peninsula and the other is west of the Barren Islands. The deferral of the area off the Kenai Peninsula would reduce the risk of oil spills contacting subsistence-harvest areas used by the Native communities of Port Graham and Nanwalek, and the deferral of both areas would reduce potential conflicts with commercial fisheries.

c. <u>Cumulative Case</u>: The analyses of the potential effects of the cumulative case for Sale 149 (Sec. IV.B.12) are based on (1) exploration, development and production, and crude-oil transportation activities in the outer continental shelf (OCS) planning areas of Cook Inlet and Shelikof Strait; (2) the major projects listed in Table IV.A.7-1; and (3) any additional projects that individual analysts feel necessary to include in their consideration of cumulative-effects analysis. The major projects considered in the cumulative-effects analyses for Sale 149 include past and foreseeable future State of Alaska and OCS oil and gas lease sales, off- and onshore oil and gas development, the timber industry, crude-oil transhipment from Valdez to Nikiski, and onshore mineral development. The OSRA model estimates a mean number of 1.01 spills ≥1,000 bbl are likely to occur as a result of the cumulative-case scenario, with an estimated 64-percent chance of one or more such spills occurring. For the purposes of analysis, this EIS assumes two 50,000-bbl spills will occur for a total spill volume of 100,000 bbl. One spill is assumed to occur in State waters and one spill is assumed to occur in Federal waters.

d. <u>200,000-bbl Oil Spill</u>: Appendix C analyzes the potential effects of a 200,000-bbl-oil spill occurring from a tanker in the Kennedy Entrance.

e. <u>OSRA, Legal, and Planning Assumptions</u>: The assumptions and the processes for performing the OSRA and for calculating the probabilities of oil spills contacting and occurring and contacting environmental resources and coastal areas are described briefly in Section IV.A.2; additional tables and figures are presented in Appendix B. Aspects of spilled oil, including (1) its fate and behavior, (2) the likelihood for contact and the extent and persistence along shorelines, (3) oil-spill-cleanup measures, and (4) toxicity in the marine environment are discussed in Section IV.A.3.

In analyzing the potential environmental effects of Sale 149, it is assumed that all activities associated with exploration, development and production, and transportation of petroleum will be performed in accordance with all applicable U.S. laws and Federal regulations. Compliance with applicable laws and regulations could mitigate some of the effects associated with petroleum exploitation. The base case of the proposed action and all alternatives to the proposal will be analyzed as though the mitigating measures contained in Section II.H will be attached as stipulations to any lease issued as a result of this sale.

Potentially affected communities should not use this EIS as a "local planning document." Site-specific planning cannot yet be done; it might be several years after the lease sale before any specific projections could be made.

The exploration, development and production, and transportation scenarios described in this document represent only some of the possible types of activities that might be used to exploit the petroleum resources of the Cook Inlet Planning Area. These scenarios are used to identify characteristic activities and areas where these activities may occur. They do not represent a recommendation, preference, or endorsement by the U.S. Department of the Interior (USDOI).

2. Oil Spills:

a. Overview and Results of the Oil-Spill-Risk-Analysis Model for Oil Spills Greater Than or Equal to 1,000 Barrels: The Minerals Management Service (MMS) OSRA uses statistical methods to evaluate historical oil spills to derive an oil spill rate, the likelihood of oil spills occurring, the estimated mean number of oil spills and the estimated size of oil spills ≥1,000 bbl from platforms, pipelines, and oil tankers (Anderson and LaBelle, 1990; LaBelle, 1990; Anderson and LaBelle, 1988; Lanfear and Amstutz, 1983). Through oil-spill-trajectory modeling, the OSRA also addresses the movement of hypothetical oil spills (trajectories) and the chance of contact to environmental resource areas, sea segments, and land segments vulnerable to those spills (Johnson et al., 1994; LaBelle and Johnson, 1993; LaBelle and Anderson, 1985; Amstutz and Samuels, 1984; Samuels, LaBelle, and Amstutz, 1982-1983; Smith et al., 1982). Environmental Resource Areas (ERA) and Sea Segments are areas where particularly notable wildlife concentrations are known to occur or are expected to be occupied frequently by portions of wildlife populations. The OSRA-model-trajectory results are appropriate only for large spills ≥1,000 bbl. The OSRA-model trajectories are used to estimate contacts over days, not hours; consequently, only those spills that are large (≥1,000 bbl) and can travel long distances or persist for several days are appropriate for the OSRA-trajectory model (Anderson and LaBelle, 1990).

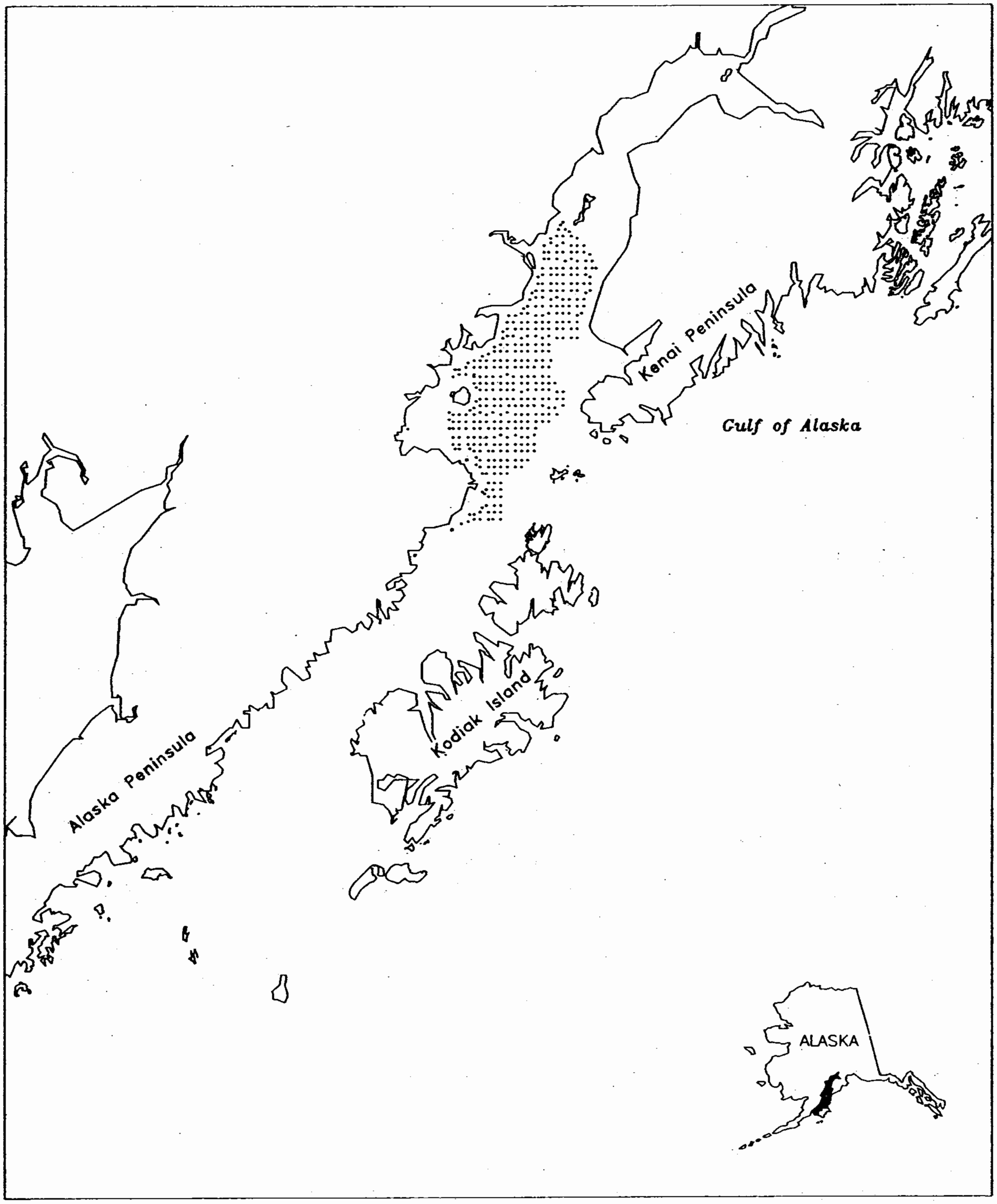
Numerous assumptions are made for the purposes of oil-spill-risk analysis. Assumptions used as inputs to the OSRA model include: (1) the total estimated amount of oil produced as a result of exploration and development from the Sale 149 proposal; (2) the approximate location of the oil assumed to be produced; (3) the assumed production processing and transportation scenarios for the proposal; and (4) the environmental resource areas, sea segments, and land segments analyzed for oil-spill-contact risk.

The OSRA model considers the entire production life of the Sale 149 proposal and assumes (1) commercial quantities of hydrocarbons are present in the sale area; (2) these hydrocarbons will be developed and produced at the estimated resource levels; and (3) oil moves without consideration of oil spreading or weathering and without any cleanup.

Uncertainties exist, such as (1) the estimates required for the previously mentioned assumptions; (2) the actual size of the oil spill or spills if they did occur; (3) the wind and current conditions at the time of a possible oil spill; or (4) whether production would occur at all. There is an estimated 90-percent chance that geologically recoverable hydrocarbons exist in the Sale 149 area. This means there is an estimated 90-percent chance that geological quantities of hydrocarbons are present and that if no hydrocarbons exist (10% chance), there is no risk of ≥1,000-bbl-oil spills occurring from the proposal. The OSRA analysis assumes that commercial quantities of hydrocarbons are produced.

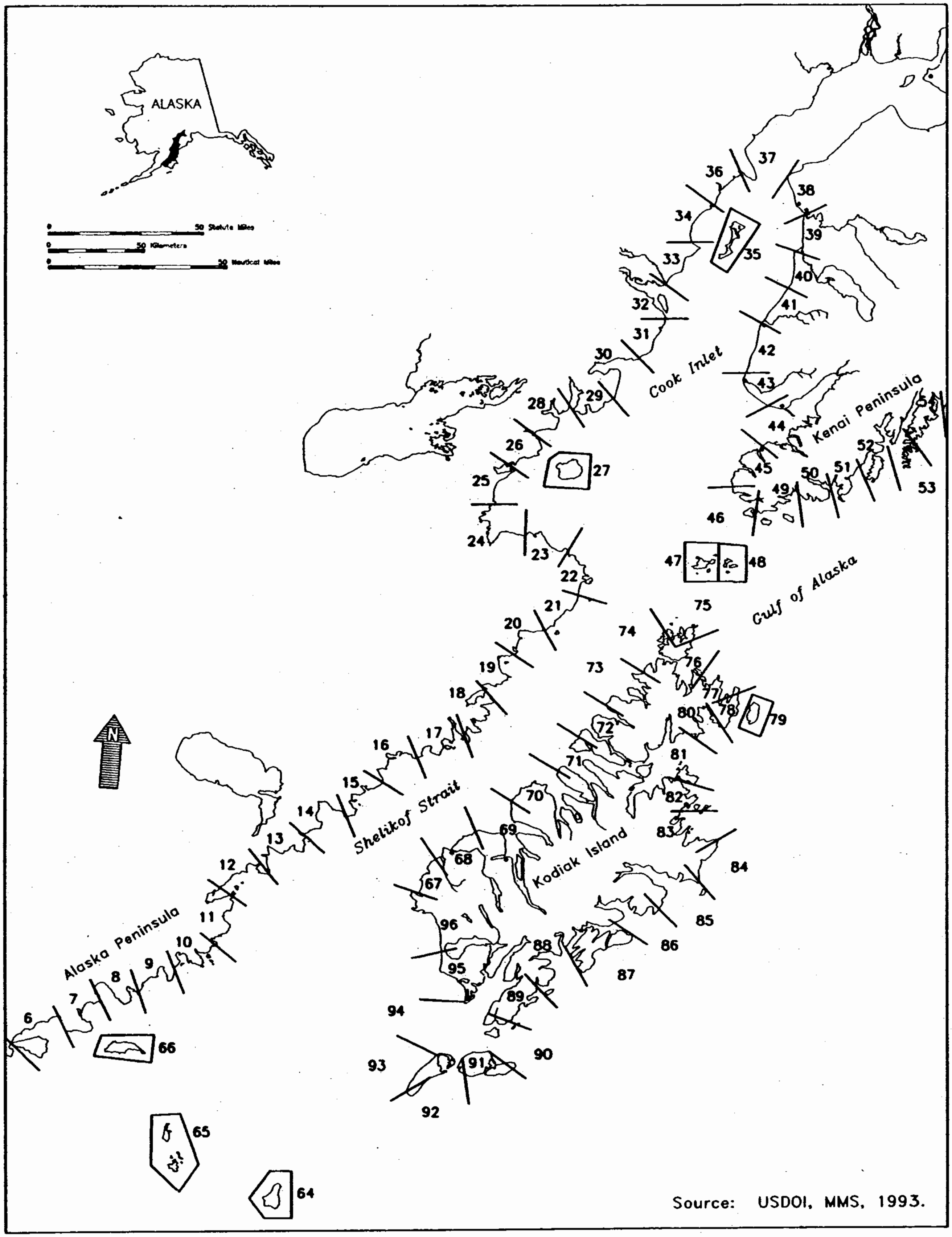
For Sale 149, the OSRA-model trajectory-study area is the Cook Inlet and Shelikof Strait region in the Gulf of Alaska (Fig. IV.A.2-1). For Sale 149, the OSRA results in an estimate of (1) the likelihood of oil spills ≥1,000 bbl occurring; (2) the likelihood of oil spills ≥1,000 bbl contacting environmental resource areas (ERA's), sea segments (SS's), or land segments (LS's), assuming a spill has occurred at a specific location (conditional probabilities); and (3) the likelihood of one or more oil spills ≥1,000 bbl occurring and contacting environmental resource areas, sea segments, or land segments from the Sale 149 activities (combined probabilities) (Johnson et al., 1994).

(1) Location of Environmental Resource Areas, Sea Segments, and Land Segments: Within the Sale 149 OSRA-model trajectory-study area, conditional and combined probabilities are calculated for 96 land segments and 31 environmental resource areas and sea segments. One of the 31 environmental resource areas is all the 96 land segments combined and is designated land. Land segments are identified in Figure IV.A.2-2 and environmental resource areas and sea segments in Table IV.A.2-1 and Figures IV.A.2-3 and IV.A.2-4.



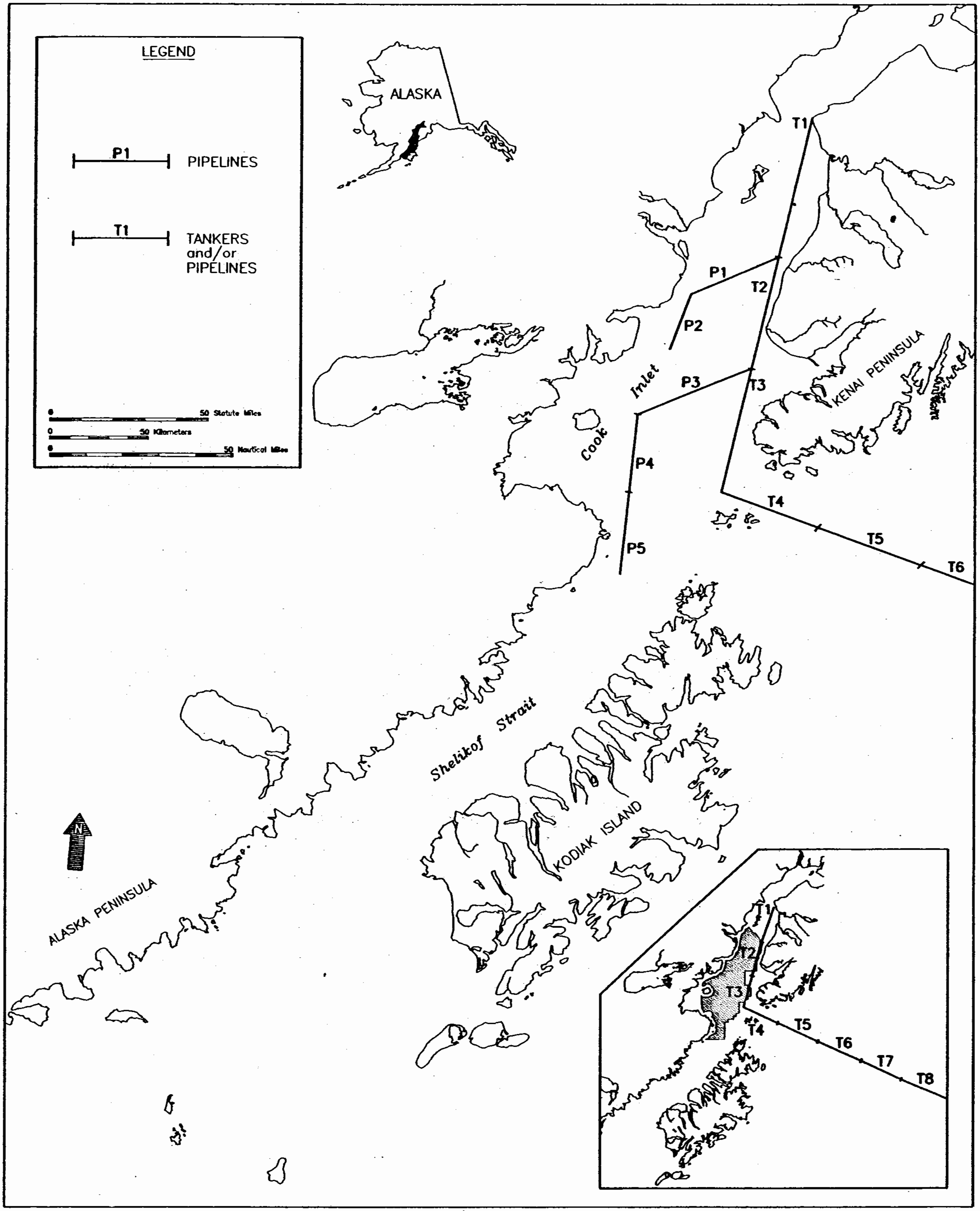
Source: USDOI, MMS, 1993.

Figure IV.A.2-1. Location of Spill-Trajectory Study Area and the 392 Hypothetical Spill Sites Used in the Oil-Spill-Risk Analysis for Sale 149.



Source: USDOI, MMS, 1993.

Figure IV.A.2–2. Land Segments Used in the Oil–Spill–Risk–Analysis for Sale 149.



Source: USDOI, MMS, 1994

Figure IV.A.2-5. Location of Hypothetical Transportation Segments for Pipelines (P1 through P5 and T1 and T2) and Tankers (T1 through T8) Used in the Oil-Spill-Risk-Analysis for Sale 149.

worldwide spill data from 1974 to 1989. For U.S. OCS platforms and pipelines, nonparametric tests indicated that the spill rate, based on volume of oil handled, had declined over time (Anderson and LaBelle, 1990). For worldwide tankers, the spill rate, based on volume of oil handled, had remained constant over time. The U.S. OCS platform- and pipeline-spill-rates are 0.60 and 0.67, respectively, per billion barrels (Anderson and LaBelle, 1990). Worldwide tanker-spill rates are 0.90 at sea and 0.47 in port per billion barrels (Anderson and Lear, 1994). The MMS uses the at-sea rate in the OSRA-model calculations for the trajectory analyses, which are not performed at ports. The export tankering-spill rate to the west coast (at sea in the inlet) is one-half of the worldwide tanker-spill rate (at sea) and is based on the simple assumption that 50 percent of the tanker spills will occur on the outbound portion of the journey in the Cook Inlet and Shelikof Strait OSRA-study region. The port-spill rate (at port in the inlet) is one-half of the port rate based on the assumption that 50 percent of the port spills will occur at the other port on the west coast.

(d) **Sale 149 Estimated Mean Spill Number and Probability of One or More Spills Greater than or Equal to 1,000 Barrels Occurring:** For the Sale 149 base, high, and cumulative cases and the deferral alternatives, the mean spill number is estimated by multiplying historical spill rates (Sec. IV.A.2.a(2)(c)) based on the assumed transportation scenario (Sec. IV.A.2.a(2)(b)) by the oil-resource-estimate volume (Sec. IV.A.2.a(2)(a)).

At-Sea Spills: The OSRA estimates a mean number of spills ≥ 1,000 bbl for the base and high cases of 0.31 and 1.26, with an estimated 27- and 72-percent chance of one or more such spills occurring, respectively (Table IV.A.2-2 and Fig. IV.A.2-6). The OSRA estimates a mean number of spills ≥ 1,000 bbl for the cumulative case of 1.01, with an estimated 64-percent chance of one or more such spills occurring (Table IV.A.2-2). The OSRA estimates ≥ 1,000 bbl mean- spill numbers of 0.26, 0.21, 0.23, 0.21, and 0.31 with estimated 23-, 19-, 21-, 19-, and 27-percent chances of one or more such spills occurring for the Wildlife Concentration, Coastal Fisheries, Pollock-Spawning Area, Northern, and Kennedy Entrance Deferral Alternatives, respectively (Table IV.A.2-2).

For purposes of analysis, based on the estimated mean number of spills, this EIS assumes one spill will occur in the base and the high cases, two spills will occur in the cumulative case, and one spill will occur in each of the deferral alternatives (Table IV.A.2-2). For the cumulative case, one spill is assumed to occur in Federal waters and one spill is assumed to occur in State waters.

Based on the assumed transportation scenario for both the base and high cases and deferral alternatives, 61 percent of the spills are estimated from pipelines and tankers and 39 percent from platforms. For the cumulative case, 70 percent of the spills are estimated from transportation and 30 percent from platforms.

In-Port Spills: The estimated mean number of spills and the probability of one or more spills ≥ 1,000 bbl occurring from tankers in port is estimated for the Nikiski port and the Drift River Terminal Facility Port (Table IV.A.2-3). Estimated in-port-spill occurrences are not included in the OSRA combined probabilities.

(4) **Spill-Size Assumptions:** A 1,000-bbl spill is the minimum-sized spill in the ≥ 1,000-bbl category and is much smaller than the average ≥ 1,000-bbl spill. Average ≥ 1,000-bbl spill sizes are 18,000 bbl for OCS platform spills, 22,000 bbl for pipelines, and 109,000 bbl for worldwide tanker spills (Anderson and LaBelle, 1990; Anderson, 1993, personal comm.). Median ≥ 1,000-bbl-spill sizes are 7,000 bbl for platforms, 6,000 bbl for pipelines, and 15,000 bbl for tankers. The Sale 149 scenarios for the base, high, and cumulative cases and deferral alternatives include platforms, pipelines, and tankers. The average of the 18,000-bbl platform, 22,0000-bbl pipeline, and 109,000-bbl tanker average spill size is 50,000 bbl and the average of the median is 9,300 bbl. For purposes of analysis, this EIS assumes an average spill size of 50,000 bbl.

In this EIS, the ≥ 1,000-bbl-spill-volume assumptions conserve both the number and total volume (average size multiplied by the number of spills) of spills ≥ 1,000 bbl. In this EIS, the assumed number of ≥ 1,000-bbl spills in Cook Inlet for the base and high cases and deferral alternatives is one spill of 50,000 bbl. In the cumulative case, two spills of 50,000 bbl each are assumed; the total spill volume for both spills is estimated as two times the 50,000-bbl average, or 100,000 bbl.

(5) **Conditional Probability of Oil-Spill Contact Assuming a Spill Has Occurred:** To estimate the conditional probability of oil-spill contact, MMS simulates oil-spill trajectories starting from hypothetical spill sites and tabulates contacts to environmental resource areas, sea segments, and land

Table IV.A.2-2
Oil-Spill-Occurrence Estimates and Probabilities for Spills ≥1,000 Barrels Resulting over the Assumed Production Life of Proposed Cook Inlet Sale 149

	Reserve Volume Produced (Bbbl)	Resource Volume Produced (Bbbl)	Estimated Mean Number of Spills CI[1] Total	Chance of One or More Spills Total (%)	Assumed Number of Spills for Analysis	Assumed Spill Size (bbl)
ALTERNATIVE I:[2]						
Base Case		0.20	0.31	27	1	50,000
Low Case		0.04	-	-	-	-
High Case		0.80	1.26	72	1	50,000
ALTERNATIVE IV:						
Wildlife Concentration		0.16	0.26	23	1	50,000
ALTERNATIVE V:						
Coastal Fisheries Deferral		0.14	0.21	19	1	50,000
ALTERNATIVE VI:						
Pollock-Spawning Area		0.15	0.23	21	1	50,000
ALTERNATIVE VIII:						
Northern Deferral		0.14	0.21	19	1	50,000
ALTERNATIVE IX:						
Kennedy Entrance Deferral		0.20	0.31	27	1	50,000
CUMULATIVE CASE:						
Federal Production						
Cook Inlet		0.20	0.31	27	1	50,000
State Production[3]						
Total	0.30		0.47	37	1	50,000
Tankering[4]						
Tankering Total	0.50		0.23	21	-	-
Cumulative-Case Total	0.80	0.20	1.01	64	2	50,000

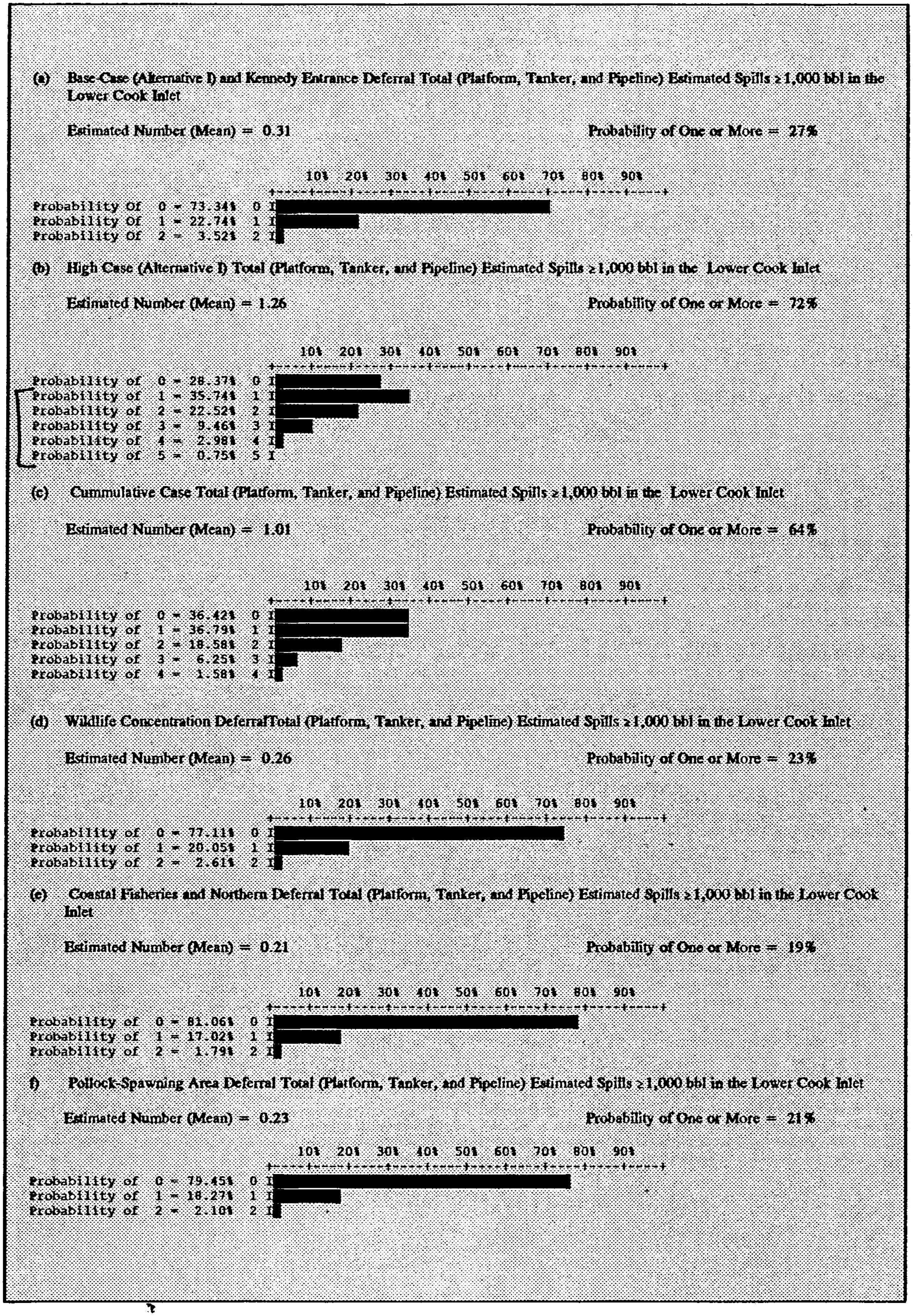
Source: USDOI, MMS, Alaska OCS Region, 1994.

[1] CI refers to Cook Inlet.

[2] The low case is based on an exploration-only scenario; spills are assumed not to occur. The base case is based on the estimated resources likely to be leased, discovered, and produced as a result of the Cook Inlet Sale 149 and assumes the existence of economically recoverable hydrocarbons in the Sale 149 area. The high case is based on similar estimated resources that are significantly higher than the base case.

[3] State production figures were estimated from State of Alaska, DNR, 1992.

[4] Valdez to Nikiski Alaska North Slope Crude Loadings (USDOT, Office of Maritime Administration, 1991).



(a) Base Case (Alternative I) and Kennedy Entrance Deferral Total (Platform, Tanker, and Pipeline) Estimated Spills ≥1,000 bbl in the Lower Cook Inlet

Estimated Number (Mean) = 0.31 Probability of One or More = 27%

```
                               10%  20%  30%  40%  50%  60%  70%  80%  90%
                             +----+----+----+----+----+----+----+----+----+----+
Probability Of  0 = 73.34%  0 I
Probability Of  1 = 22.74%  1 I
Probability Of  2 =  3.52%  2 I
```

(b) High Case (Alternative I) Total (Platform, Tanker, and Pipeline) Estimated Spills ≥1,000 bbl in the Lower Cook Inlet

Estimated Number (Mean) = 1.26 Probability of One or More = 72%

```
                               10%  20%  30%  40%  50%  60%  70%  80%  90%
                             +----+----+----+----+----+----+----+----+----+----+
Probability of  0 = 28.37%  0 I
Probability of  1 = 35.74%  1 I
Probability of  2 = 22.52%  2 I
Probability of  3 =  9.46%  3 I
Probability of  4 =  2.98%  4 I
Probability of  5 =  0.75%  5 I
```

(c) Cummulative Case Total (Platform, Tanker, and Pipeline) Estimated Spills ≥1,000 bbl in the Lower Cook Inlet

Estimated Number (Mean) = 1.01 Probability of One or More = 64%

```
                               10%  20%  30%  40%  50%  60%  70%  80%  90%
                             +----+----+----+----+----+----+----+----+----+----+
Probability of  0 = 36.42%  0 I
Probability of  1 = 36.79%  1 I
Probability of  2 = 18.58%  2 I
Probability of  3 =  6.25%  3 I
Probability of  4 =  1.58%  4 I
```

(d) Wildlife Concentration DeferralTotal (Platform, Tanker, and Pipeline) Estimated Spills ≥1,000 bbl in the Lower Cook Inlet

Estimated Number (Mean) = 0.26 Probability of One or More = 23%

```
                               10%  20%  30%  40%  50%  60%  70%  80%  90%
                             +----+----+----+----+----+----+----+----+----+----+
Probability of  0 = 77.11%  0 I
Probability of  1 = 20.05%  1 I
Probability of  2 =  2.61%  2 I
```

(e) Coastal Fisheries and Northern Deferral Total (Platform, Tanker, and Pipeline) Estimated Spills ≥1,000 bbl in the Lower Cook Inlet

Estimated Number (Mean) = 0.21 Probability of One or More = 19%

```
                               10%  20%  30%  40%  50%  60%  70%  80%  90%
                             +----+----+----+----+----+----+----+----+----+----+
Probability of  0 = 81.06%  0 I
Probability of  1 = 17.02%  1 I
Probability of  2 =  1.79%  2 I
```

f) Pollock-Spawning Area Deferral Total (Platform, Tanker, and Pipeline) Estimated Spills ≥1,000 bbl in the Lower Cook Inlet

Estimated Number (Mean) = 0.23 Probability of One or More = 21%

```
                               10%  20%  30%  40%  50%  60%  70%  80%  90%
                             +----+----+----+----+----+----+----+----+----+----+
Probability of  0 = 79.45%  0 I
Probability of  1 = 18.27%  1 I
Probability of  2 =  2.10%  2 I
```

Figure IV.A.2-6 Poisson Distribution of Spill Occurrence Probabilities for the Base, High, and Cumulative Cases and the Wildlife Concentration, Coastal Fisheries, Pollock-Spawing Area, Northern, and Kennedy Entrance Deferrals

Table IV.A.2-3

Oil-Spill-Occurrence Estimates and Probabilities for In-Port Tanker Spills ≥1,000 Barrels Resulting over the Assumed Production Life of Proposed Cook Inlet Sale 149

Port	Nikiski		Drift River Facility	
Case	Estimated Mean Number of Port Spills	Probability of One or More Port Spills (%)	Estimated Mean Number of Port Spills	Probability of One or More Port Spills (%)
Base Case	0.03	3	-	-
Low Case	-	-	-	-
High Case	0.12	11	-	-
Wildlife Concentration Deferral	0.02	2	-	-
Coastal Fisheries Deferral	0.02	2	-	-
Pollock-Spawining Area Deferral	0.02	2	-	-
Northern Deferral	0.02	2	-	-
Kennedy Entrance Deferral	0.03	3	-	-
Cumulative Case[1]	0.17	16	0.03	3

Source: USDOI, MMS, 1994.

Note: - means not included in the scenario.

[1] For calculation of port spills for the cummulative case, McArthur River, West McArthur River, Trading Bay and Granite Point (0.183 billion barrels [Bbbl]) are piped to Drift River. Middle Ground Shoal, Beaver Creek, and Swanson River are piped to Nikiski. It is assumed Sunfish oil would be piped to Nikiski for a total of 0.115 Bbbl. It is assumed 100 percent of the oil tankered from Valdez and foreign import tankering is received at the Nikiski Port and 66 percent of the base-case and State production oil is tankered out of Cook Inlet.

segments. The conditional probability is the likelihood of a spill contacting environmental resource areas or land/sea segments assuming that an oil spill occurs from a hypothetical spill site. Seasonal (summer and winter), conditional probabilities were estimated for the Cook Inlet Sale 149 area.

(a) Oil-Spill-Trajectory Simulations: The trajectory simulation consists of numerous hypothetical oil-spill trajectories that collectively represent the mean surface transport and the variability of the surface transport as a function of time and space. The trajectories represent the Lagrangian motion that a particle on the surface might take under given wind and ocean-current conditions. Multiple trajectories are simulated to give a statistical representation, over time and space, of possible transport under the range of wind and ocean-current conditions that exist in the Sale 149 area. In the Sale 149 OSRA-trajectory model, sea ice is not modeled.

Trajectories are constructed from simulations of tidal, wind-driven, and density-induced flow fields. The basic approach is to simulate these time- and spatially dependent currents separately and then combine them through linear superposition to produce an oil-transport vector that is then used to create a trajectory. Because of the small amount of salinity and temperature data available in the Cook Inlet and Shelikof Strait region, simulations are carried out for two seasons, winter (October-March) and summer (April-September). This seasonal division was chosen based on meteorological, climatological, and biological cycles, as well as consultation with MMS, Alaska OCS Region analysts. Johnson et al. (1994) describes the modeling of each flow-field component.

For each trajectory simulation, the start time for the first trajectory was the first day of the season (winter or summer) of the first year of wind data (1978) at 6 a.m. Greenwich Mean Time (GMT). Each subsequent trajectory was started every 1.5 days on average (e.g., either every first day or every second day), at 6 a.m. GMT. One thousand hypothetical oil-spill trajectories were simulated for the winter and summer (2,000 total) from each of the 392 hypothetical spill sites (Fig. IV.A.1). Transportation risks were represented by a total of 2,000 trajectories (1,000 in winter; 1,000 in summer) launched from each transportation segment over the 9-year period of wind data (1978-1986). Using the start time, the current field was assembled to establish the tidal currents, the appropriate seasonal diagnostic density current, and the wind data to be used. Each simulation lasted for up to 30 days, and data from each flow field were matched in time and space and to create a final U_{oil}. The U_{oil} term is the oil-drift vector.

A major assumption used in this analysis is that the mean flows are quasi-steady and that they can be adequately represented by addition of the flow components. More specifically, this assumption implies that the nonlinear interactions are small and do not substantively contribute to the circulation. Field and theoretical studies are under way presently to quantify these effects, not only in the study area but also throughout the world's oceans (Westerink, Stolzenback, and Connor, 1989). Sensitivity tests and comparisons with data illustrate that the linear superposition captures the first-order transport and the dominant flow. Trajectories were calculated by the OSRA model and contacts to land/sea segments and environmental resource areas were tabulated. Trajectories and overlays of land/sea segments and environmental resource areas were examined to ensure that contacts were properly established and tabulated.

(b) Sale 149 Conditional Probabilities: The estimated conditional probabilities (expressed as percent chance) are presented as: (1) contacts with summer spills during open water and (2) contacts with winter spills during open water for 3, 10, and 30 days for environmental resource areas, sea segments, and land segments. In many cases, there was little difference between the 10-day and 30-day estimated probabilities. This is because the study area is restricted within Cook Inlet and Shelikof Strait, and long travel times for oil-spill trajectories were not observed. The estimated conditional probabilities of oil-spill contact from transportation segments P1 through P5 and T1 through T8 are presented in Tables B-2 through B-13 in Appendix B. The conditional probabilities of oil-spill contact from the 392 spill sites (roughly 1 per lease block) are presented as risk-contour maps in the Sale 149 OSRA report (Johnson et al., 1994) and some representative examples in Appendix B, Figures B-1 through B-29.

The conditional probability risk-contour map is generated by drawing contours through the hypothetical spill sites that show a seasonal conditional probability of contacting a specific environmental resource area, sea segment, or land segment within sets of predesignated ranges. The ranges of seasonal conditional probabilities that were used to generate the contours are 5-, 25-, 50-, 75-, and 95 percent. For example, if there are contours labeled "50" and

"75," it means that all the hypothetical spill sites that lie between those contours have a seasonal conditional probability of contact between 51 and 74 percent.

Alternative IX, the Kennedy Entrance Deferral, deletes nine blocks adjacent to the Barren Islands and eight blocks adjacent to the Kenai Peninsula from the Sale 149 Area. It is analyzed using the conditional risk contours from the Oil Spill Risk Analysis (OSRA) for environmental resource areas and land segments for summer and winter within 3, 10, and 30 days. The conditional risk contours estimate the range of probabilities of a spill occurring within a conditional risk contour contacting the ERA's or LS's in summer and winter within 3, 10, and 30 days (Appendix B, Figs. B-1 through B-29).

For the nine blocks that are adjacent to the Barren Islands, the OSRA estimates the greatest chance of contact from these blocks (and therefore the largest reduction by their removal) is to ERA's 6,7, 9, and 12 and LS 47 (Barren Islands, Cape Douglas, Hallo/Kukak Bays, Puale Bay, and Barren Island respectively). Very small (insignificant) reductions in the chance of contact are estimated for ERA's 4, 5, 6, 8, 10, and 11 and LS's 18, 19,20, 21, 22, and 23 (Figs. IV.A.2- 2 and IV.A.2-3).

The above conclusion, based on the removal of the nine blocks adjacent to the Barren Islands, is derived from the following data. For ERA 6, the OSRA estimates most hypothetical production-spill sites with a ≥25- and <50-percent chance of contact within 10 and 30 days during summer are removed. For ERA 7, the OSRA estimates that some hypothetical production-spill sites with a ≥50- and <75-percent chance of contact are removed with the deletion of the nine blocks during summer and winter within 30 days. For ERA 9, some of the hypothetical production sites with a ≥25- and <50-percent chance of contact are removed during summer or winter within 3, 10, and 30 days. For ERA 12, some of the hypothetical production-spill sites with a ≥5- and <25 percent chance of contact are removed during summer or winter within 3, 10, and 30 days. For LS 47, the OSRA estimates that most hypothetical production sites with a >5- and <25-percent chance of contact within 3 days are removed with the deletion of the nine blocks and some hypothetical production sites with a >5- and <25- percent chance of contact within 10 and 30 days during summer and winter are removed.

For the eight blocks adjacent to the Kenai Peninsula that are to be removed, the OSRA risk contour estimates indicate the greatest chance of contact from these blocks (and therefore the largest reduction by their removal) is to ERA 3 and LS 45. Very small (insignificant) reductions in the chance of contact from the removal of the 8 blocks are estimated for ERA's 4, 5, 6, 7, and 9 and LS's 23, 24, 27, 28, 29, and 44 (Figs. IV.A.2- 2 and IV.A.2-3).

The above conclusion, based on the removal of eight blocks adjacent to the Kenai Peninsula is reached from the following data. All hypothetical production-spill sites with a >50 percent chance of contact to ERA 3 are removed with the deletion of the eight blocks. Some but not all hypothetical production-spill sites with a >25- and <50 percent chance of contact are removed during summer or winter within 3, 10, and 30 days. For LS 45, all hypothetical production-spill sites with a >5- and <25-percent chance of contact within 3 days are removed with the deletion of the eight blocks and most of the total hypothetical platform sites with a >5- and <25-percent chance of contact within 10 and 30 days during summer and winter are removed. A few of the hypothetical production-spill sites with a >5- and <25-percent chance within 3 days of contacting ERA's 4, 5, 6, 7, and 9 and LS's 23, 24, 27, 28, 29, and 44 during summer or winter are removed with the deletion of the 8 blocks.

(6) **Combined Probability of Oil-Spill Occurrence and Contact:** Combined probabilities are estimated using the conditional probabilities, the historical oil-spill rates, the resource estimates, and the assumed transportation scenarios. These are combined through matrix multiplication to estimate the mean number of spills occurring and contacting environmental resource areas or land/sea segments. The estimated mean spill number is then applied to the Poisson statistical distribution to estimate the probability of one or more spills ≥1,000 bbl occurring and contacting environmental resource areas and land/sea segments over the lifetime of the Sale 149 proposal.

The combined probability is the likelihood of one or more ≥1,000-bbl spills occurring and contacting environmental resource areas, sea segments, or land segments from production and transportation activities over the lifetime of the Sale 149 proposal. It is important that the distinction between conditional and combined probabilities is clear. Conditional probabilities assume a spill has occurred and refer only to the likelihood that a spill would follow a certain path and have nothing to do with the chance that a spill would occur in the first place.

Combined probabilities reflect both the estimated chance of a spill occurring as well as the likelihood that a spill would follow a certain path.

Sale 149 Combined Probabilities for Environmental Resource Areas: The combined probabilities are presented as the probability of one or more ≥1,000-bbl spills occurring and contacting environmental resource areas, sea segments, or land segments within 3, 10, and 30 days over the assumed production life of the proposal. Combined-probability tables for the base and high cases are in Appendix B, Table B-14, and in Figures IV.A.2-7 and IV.A.2-8. Combined-probability tables for the deferral alternatives are in Appendix B, Tables B-15, B-16, and B-17 and in Figures IV.A.2-7 and IV.A.2-8.

b. Spills Less Than 1,000 Barrels: Most United States OCS spills less than (<) 1,000 bbl usually are <50 bbl. In fact, 99 percent of all United States OCS spills (including spills less than or equal to [≤] 1 bbl) have been ≤10 bbl in size (Anderson, 1993, personal comm.). Worldwide, <50-bbl oil spills from platforms contribute 0.02 to 0.03 MMbbl annually to a total oceanic release from offshore petroleum production of 0.3 to 0.5 MMbbl (National Research Council [NRC], 1985). Therefore, worldwide, <50-bbl spills make up 4 to 10 percent of the total industry discharge.

During exploration in Alaskan OCS waters from 1982 to 1991, 52 exploration wells were drilled with five spills greater than (>) 1 bbl and a total spillage of 45 bbl. From the Alaskan OCS data, the spill rate is 11 spills per 100 wells drilled, with a 9-bbl-per-spill-average volume.

Spills <1,000 bbl will be more frequent during the production years, but the anticipated spill volumes still will be small. Between 1971 and 1980 in Cook Inlet, the spill rate was 265 spills per billion barrels produced and transported. No reported spills in this timeframe were as large as 1,000 bbl; and the average size was 4.4 bbl (Sale 109 FEIS [USDOI, MMS, Alaska OCS Region, 1987]).

In OCS producing areas from 1964 to 1992, the offshore-oil industry spilled 14,080 bbl in 88 small spills (of at least 50 bbl but <1,000 bbl) while producing 8.96 Bbbl (crude and condensate). The OCS data show an OCS production-spill rate of 9.8 spills ≥50 and <1,000 bbl in size per billion barrels produced, with an average 160-bbl-spill size (Tracey, 1988; Francois 1993; Anderson, 1994, personal comm.). In OCS producing areas from 1970 to 1992, the offshore-oil industry spilled 9,184 bbl in 1,812 small spills (of at least 1 bbl but <50 bbl) while producing 7.7 MMbbl (crude and condensate) (Francois, 1993; Cotton, 1991; Anderson, 1994, personal comm.). The OCS data show an OCS production-spill rate of 234 spills ≥1 and <50 bbl in size per billion barrels produced, with an average 5-bbl-spill size.

Sale 149 Estimated Production Spills Less Than 1,000 Barrels: Table IV.A.2-4a through IV.A.2-4e present small-spill estimates for the low, base, high, and cumulative cases and Wildlife Concentration, Coastal Fisheries, Pollock-Spawning Area, Northern, and Kennedy Entrance Deferral Alternatives.

3. Spilled Oil Fate and Behavior in Marine Waters: Subarctic oil-spill fate and behavior is discussed in the Sale 107 FEIS, Section IV.A.2.a (USDOI, MMS, Alaska OCS Region, 1991), and is incorporated by reference, summarized, and updated. Oil-spill cleanup is not considered in the following discussion. Although cleanup is required by law, effectiveness is uncertain and depends greatly on local conditions, type and quantity of oil, logistics, and shoreline character. Oil-spill response and cleanup are discussed in Section IV.A.4.

Several processes alter the chemical and physical characteristics and toxicity of spilled oil. Collectively, these processes are referred to as weathering or aging of the oil and, along with the physical oceanography and meteorology, the weathering processes determine the oil's fate. The major oil weathering processes are spreading, evaporation, dispersion, dissolution, emulsification, microbial degradation, and sedimentation to the seafloor or stranding on the shoreline (Payne and McNabb, 1985; Payne et. al., 1987; Boehm, 1987) (Figs. IV.A.3-1 and IV.A.3-2).

a. General Weathering Processes: After a spill occurs, spreading and advection begin. The slick spreads horizontally in an elongated pattern oriented in the direction of wind and currents and nonuniformly into thin sheens (0.5-10 μm) and thick patches (0.1-10 mm) (Elliott, 1986; Elliott, Hurford, and Penn, 1986; Galt et al., 1991). In the cooler subarctic CI/SS waters, oil spills spread less and remain thicker than in temperate waters due to differences in the viscosity of oil. The presence of broken ice tends to slow the rate of

Environmental Resource Areas	Base[1] Case			Northern Deferral			Wildlife Concentration Deferral			Pollock Spawning Area Deferral			Coastal Fisheries Deferral		
	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days
Land	15	24	26	10	17	19	12	19	21	12	19	20	10	17	19
1	6	7	7	2	3	3	4	5	5	6	6	6	4	5	5
2	2	2	2	1	1	1	1	2	2	2	2	2	1	2	2
3	3	4	4	2	3	3	3	3	3	2	3	3	2	3	3
4	6	8	8	5	7	7	5	7	7	4	6	6	4	6	6
5	2	4	4	2	3	3	2	3	3	1	2	3	1	2	2
6	1	2	2	1	2	2	1	2	2	1	1	2	1	2	2
7	3	4	4	2	4	4	2	3	3	1	2	2	2	3	3
8	n	1	1	n	1	1	n	1	1	n	n	1	n	1	1
9	1	1	2	1	1	1	n	1	1	n	n	1	n	1	1
10	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
11	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
12	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
13	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
14	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
15	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
16	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
17	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
18	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
19	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
20	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
21	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
22	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
23	n	n	1	n	n	n	n	n	n	n	n	n	n	n	n
24	n	n	1	n	n	n	n	n	n	n	n	n	n	n	n
25	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1
26	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
Sea Segment 1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Sea Segment 2	4	4	4	2	2	2	3	3	3	3	4	4	3	3	3
Sea Segment 3	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
Sea Segment 4	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n

Legend					
n	<0.5 Percent	10	10 Percent	30	30 Percent
5	5 Percent	20	20 Percent		

Source: Appendix B, Table B-14, B-15 and B-16.

[1] The Kennedy Entrance Deferral is similar to the base case. Slight differences are discussed in Section IV.A.2.a(5)(b).

Figure IV.A.2-7 Estimated Combined Probabilities (expressed as percent chance) of One or More Spills Greater Than or Equal to 1,000 Barrels Occurring and Contacting Certain Environmental Resource Areas Over the Assumed Life of the Cook Inlet Sale 149.

	Base[1] Case			Northern Deferral			Wildlife Concentration Deferral			Pollock Spawing Area Deferral			Coastal Fisheries Deferral		
Land Segment	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days
18	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
19	n	n	1	n	n	1	n	n	n	n	n	n	n	n	n
20	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
21	n	1	1	n	1	1	n	n	n	n	n	n	n	n	1
22	1	2	2	1	1	1	1	1	1	n	1	1	1	1	1
23	1	1	1	n	1	1	1	1	1	n	1	1	1	1	1
24	n	1	1	n	1	1	n	1	1	n	1	1	n	1	1
25	n	1	1	n	1	1	n	1	1	n	n	1	n	n	n
26	n	1	1	n	1	1	n	1	1	n	1	1	n	1	1
27	1	2	2	1	2	2	1	2	2	1	2	2	1	1	1
28	n	1	1	n	1	1	n	1	1	n	1	1	n	1	1
29	1	2	2	1	1	1	1	1	2	1	1	2	1	1	1
30	1	2	2	1	1	1	1	2	2	1	2	2	1	1	1
31	1	2	2	1	1	1	1	1	1	1	2	2	1	1	1
32	2	2	2	1	1	1	1	2	2	1	2	2	1	2	2
33	1	1	1	n	n	1	1	1	1	1	1	1	1	1	1
35	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1
38	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
39	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
40	n	1	1	n	n	n	n	n	n	n	n	1	n	n	n
41	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
42	1	1	1	n	n	n	n	1	1	n	1	1	n	n	n
43	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
44	n	n	1	n	n	n	n	n	n	n	n	n	n	n	n
45	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
46	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
47	n	n	1	n	n	n	n	n	n	n	n	n	n	n	n
48	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
73	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
74	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
75	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
76	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
77	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
79	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n

Legend n <0.5 Percent 1 1 Percent 2 2 Percent

Source: Appendix B, Tables B-14, B-15 and B-17.

[1] The Kennedy Entrance Deferral is similar to the base case. Slight differences are discussed in Section IV.A.2.a(5)(b).

Figure IV.A.2-8 Estimated Combined Probabilities (expressed as percent chance) of One or More Spills Greater Than or Equal to 1,000 Barrels Occurring and Contacting Certain Land Segments Over the Assumed Life of the Cook Inlet Sale 149.

Table IV.A.2-4a
Estimated Exploration Small Spills ≥1 and <1,000 Barrels

Case	Number of Wells	Spill Size (bbl)	Spill Rate (Spills/ Wells)	Estimated Number of Spills	Average Size (bbl)	Total Volume (bbl)
Base Case	8	≥1 and <1000	11/100[1]	0	9[1]	0
High Case	27	≥1 and <1000	11/100[1]	3	9[1]	27
Cumulative Case	11	≥1 and <1000	11/100[1]	1	9[1]	9
Wildlife Concentration Deferral	7	≥1 and <1000	11/100[1]	0	9[1]	0
Coastal Fisheries Deferral	5	≥1 and <1000	11/100[1]	0	9[1]	0
Pollock-Spawning Area Deferral	7	≥1 and <1000	11/100[1]	0	9[1]	0
Northern Deferral	5	≥1 and <1000	11/100[1]	0	9[1]	0
Kennedy Entrance Deferral	8	≥1 and <1000	11/100[1]	0	9[1]	0

Table IV.A.2-4b
Estimated Production Small Spills ≥1 and <50 Barrels

Case	Resource Volume (Bbbl)	Spill Size (bbl)	Spill Rate (Spills/ Bbbl)	Estimated Number of Spills	Average Size (bbl)	Total Volume (bbl)
Base Case	0.20	≥1 and <50	234/Bbbl[2]	47	5[2]	235
High Case	0.80	≥1 and <50	234/Bbbl[2]	187	5[2]	935
Cumulative Case	0.50	≥1 and <50	234/Bbbl[2]	117	5[2]	585
Wildlife Concentraion Deferral	0.16	≥1 and <50	234/Bbbl[2]	37	5[2]	185
Coastal Fisheries Deferral	0.14	≥1 and <50	234/Bbbl[2]	33	5[2]	165
Pollock-Spawning Area Deferral	0.15	≥1 and <50	234/Bbbl[2]	35	5[2]	175
Northern Deferral	0.14	≥1 and <50	234/Bbbl[2]	33	5[2]	165
Kennedy Entrance Deferral	0.20	≥1 and <50	234/Bbbl[2]	47	5[2]	235

Table IV.A.2-4c
Estimated Production Small Spills ≥50 and <1,000 Barrels

Case	Resource Volume (Bbbl)	Spill Size (bbl)	Spill Rate (Spills/ Bbbl)	Estimated Number of Spills	Average Size (bbl)	Total Volume (bbl)
Base Case	0.20	≥50 and <1,000	10/Bbbl[3]	2	160[3]	320
High Case	0.80	≥50 and <1,000	10/Bbbl[3]	8	160[3]	1,280
Cumulative Case	0.50	≥50 and <1,000	10/Bbbl[3]	5	160[3]	800
Wildlife Concentration Deferral	0.16	≥50 and <1,000	10/Bbbl[3]	2	160[3]	320
Coastal Fisheries Deferral	0.14	≥50 and <1,000	10/Bbbl[3]	1	160[3]	160
Pollock-Spawning Area Deferral	0.15	≥50 and <1,000	10/Bbbl[3]	2	160[3]	320
Northern Deferral	0.14	≥50 and <1,000	10/Bbbl[3]	1	160[3]	160
Kennedy Entrance Deferral	0.20	≥50 and <1,000	10/Bbbl[3]	2	160[3]	320

Source: USDOI, MMS, Alaska OCS Region, 1994.

Note: The cumulative-case small spills include only resource and reserve volumes from State and Federal waters. Tankered volumes from Valdez and foreign ports are not included.

[1] Calculated with oil-spill data from 1982-1991 from the Alaska OCS Region.

[2] Calculated with oil-spill data from 1970-1992 from Anderson (1994) and production data from 1970-1992 from Francois (1993).

[3] Calculated with oil-spill data from 1964-1970 from Tracey (1988), oil-spill data from 1971 to 1990 from Cotton (1991), 1964-1992 oil-spill data from Anderson (1994), and production data from 1964 to 1992 from Francois (1993).

Table IV.A.2-4d
Estimated Total Spills ≥1 and <1,000 Barrels

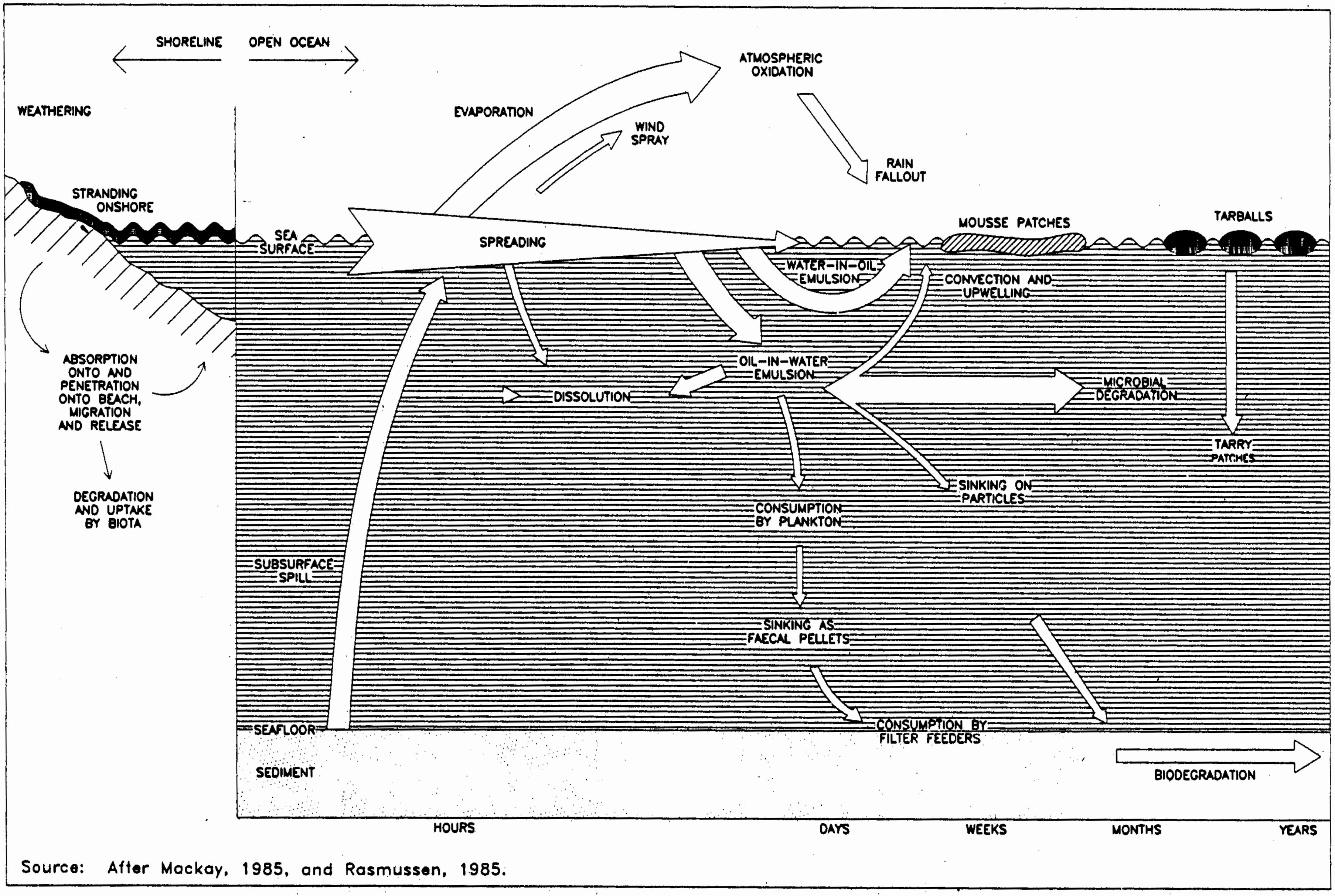
Case	Resource Volume (Bbbl)	Spill Size (bbl)	Total Estimated Number of Spills	Total Volume (bbl)
Base Case Total	0.20	≥1 and <1,000	49	555
High Case Total	0.80	≥1 and <1,000	198	2,242
Cummulative Case Total	0.05	≥1 and <1,000	123	1,394
Wildlife Concentration Deferral Total	0.16	≥1 and <1,000	39	505
Coastal Fisheries Deferral Total	0.14	≥1 and <1,000	34	325
Pollock-Spawning Area Deferral Total	0.15	≥1 and <1,000	37	495
Northern Deferral Total	0.14	≥1 and <1,000	34	325
Kennedy Entrance Deferral Total	0.20	≥1 and <1,000	49	555

Table IV.A.2-4e
Estimated Total Small Spills ≥1 and <1,000 Barrels for the Cumulative Case and Their Assumed Distribution

Case	Resource Volume (Bbbl)	Spill Size (bbl)	Estimated Number of Spills	Total Volume (bbl)
Cumulative Case Total	0.5	≥1 and <1,000	123	1,394
State Onshore	0.12	≥1 and <1,000	29	300
State Waters	0.18	≥1 and <1,000	44	530
Federal Waters	0.20	≥1 and <1,000	50	564

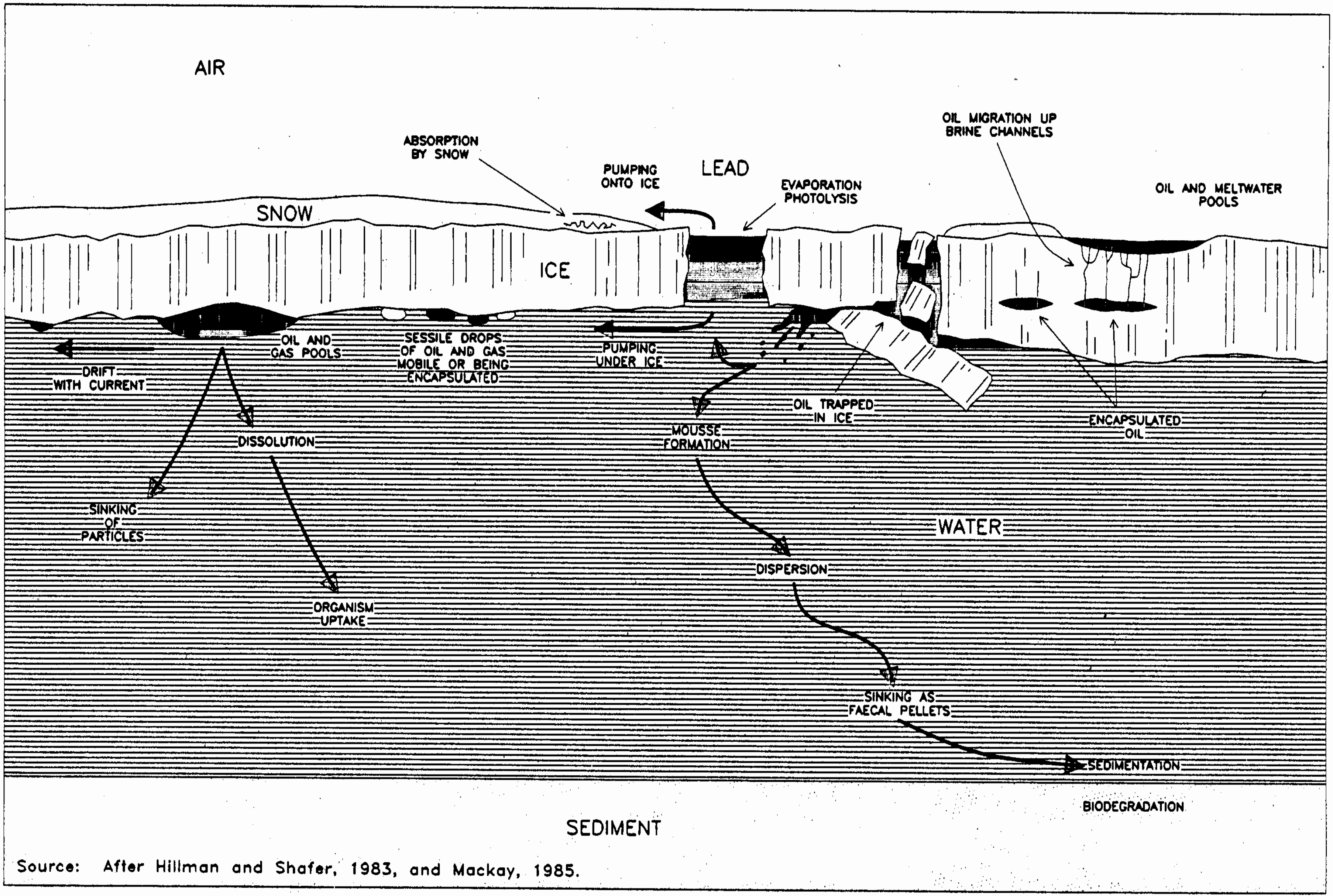
Source: USDOI, MMS, Alaska OCS Region, 1994.

Note: The cumulative-case small spills include only resource and reserve volumes from State and Federal waters. Tankered volumes from Valdez and foreign ports are not included.



Source: After Mackay, 1985, and Rasmussen, 1985.

Figure IV.A.3-1. Fate of Oil Spills in the Ocean During Summer.



Source: After Hillman and Shafer, 1983, and Mackay, 1985.

Figure IV.A.3-2. Fate of Oil Spills in the Ocean During Winter.

spreading. Oil spilled beneath a wind-agitated field of pancake ice would be pumped up onto the surface of the ice or, if currents are slow enough, bound up in or below the ice (Payne et al., 1987). Once oil is encapsulated in ice, it has the potential to move distances from the spill site with the ice.

Evaporation results in a preferential loss of the lighter, more volatile hydrocarbons, increasing density and viscosity and reducing vapor pressure and toxicity (MacKay, 1985). Evaporation of volatile components accounts for 30 to 50 percent of crude loss, with approximately 25 percent occurring in the first 24 hours (Fingas, Duval, and Stevenson, 1979; National Resource Council, 1985). The initial evaporation rate increases with increasing wind speeds, temperatures, and sea state. Evaporative processes occur on spills in ice-covered waters, although at a lower rate (Jordan and Payne, 1980). Fuel oils (diesel) evaporate more slowly than crude, on the order of 13 percent within 40 hours at 23 °C, but a larger overall percentage of diesel eventually will evaporate. Evaporation decreases in the presence of broken ice and stops if the oil is under or encapsulated in the ice (Payne et al., 1987).

Dispersion is an important breakup process that results in the transport of small oil particles (0.5 μm-several mm) or oil-in-water emulsions into the water column (Jordan and Payne, 1980; NRC, 1985). Droplets <0.5 mm rise slowly enough to remain dispersed in the water column (Payne and McNabb, 1985). The dispersion rate is directly influenced by sea state; the higher the sea state and breaking waves, the more rapid the dispersion rate (Mackay, 1985). The presence of broken ice promotes dispersion (Payne et al., 1987).

Dissolution results in the loss of soluble, low-molecular-weight (LMW) aromatics such as benzene, toluene, and xylenes (NRC, 1985). The LMW aromatics, which are acutely toxic, rapidly dissolve into the water column. Dissolution, however, is very slow compared to evaporation; most volatiles usually evaporate rather than dissolve. Dissolved-hydrocarbon concentrations underneath a slick, therefore, tend to remain <1 parts per million (ppm) (Malins and Hodgins, 1981). Dissolved-hydrocarbon concentration can increase due to the promotion of dispersion by broken ice (Payne et al., 1987).

Emulsified oil results from oil incorporating water droplets in the oil phase and generally is referred to as mousse (Mackay, 1982). The measurable increases in viscosity and specific gravity observed for mousse change its behavior, including spreading, dispersion, evaporation, and dissolution. The formation of mousse slows the subsequent weathering of oil. The presence of slush ice and turbulence promotes oil-in-water emulsions (Payne et al, 1987).

Most of the oil droplets suspended in the water column eventually will be degraded by bacteria in the water column or deposited on the seafloor. The rate of sedimentation depends on the suspended load of the water, the water depth, turbulence, oil density, and incorporation into zooplankton fecal pellets.

b. **Additional Subsurface Weathering Processes**: Subsurface blowouts or gathering-pipeline spills disperse small oil droplets and entrained gas into the water column. With sufficient gas, turbulence, and the necessary precursors in the oils, mousse forms by the time the oil reaches the surface (Payne, 1982; Thomas and McDonagh, 1991). For subsurface spills, oil rises rapidly to the water surface to form a slick. Droplets <50 microns in size, generally 1 percent of the blowout volume, could be carried several kilometers downcurrent before reaching the water surface (Environmental Sciences Limited, 1982). Blowout simulations show that convective cells set up by the rising oil and gas plume result in concentric rings of waves around the central plume. Surface currents within the ring should move outward, and surface currents outside the ring should move inward, resulting in a natural containment of some oil.

The subsurface release of oil droplets increases slightly the dissolution of oil, but the rapid rise of most oil to the surface suggests that the increase in dissolution—as a percentage of total spill volume—is fairly small. The resulting oil concentration, however, could be substantial, particularly for dispersed oil in subsurface plumes.

c. *Exxon Valdez* Oil Spill (EVOS) Fate and Weathering:

(1) **EVOS Fate**: The EVOS began on March 24, 1989. Approximately 11 million gallons (240,000 bbl) of North Slope crude oil leaked from its tanks (State of Alaska, Dept. of Environmental Conservation, 1993). Wolfe et al. (1993) estimated that 20 percent of EVOS oil evaporated, 20 to 25 percent dispersed, 25 percent was carried out of Prince William Sound (PWS), and 40 to 45 percent beached in PWS. For the dissolved and dispersed hydrocarbons in the water column: (1) the volatile monoaromatic hydrocarbons were 2

parts per billion (ppb) after 2 weeks, decreasing to 0.18 ppb at the end of April (Neff, 1990; 1991b); and (2) the total polynuclear aromatic hydrocarbons in the water column ranged from 1 to 7 ppb near heavily oiled beaches (Neff, 1991b; Payne et al. 1991; Short and Rounds, 1993). For the beached hydrocarbons in PWS, 75 to 90 percent of surface oil was removed after winter 1989-1990, and 40 percent of the subsurface oil was removed (Jahns et al, 1991; Michel et al., 1991; Michel and Hayes, 1993b; Owens, 1991). In 1992, the remaining surface oil consisted of mousse, asphalt pavement, water-surface sheens, flake, and tar stains (Owens, 1991; Roberts et al., 1993). Subsurface oil remains in a small number of locations; subsurface oil caused sheening problems 3.5 years after the spill (Michel and Hayes, 1993a). In 1992, the remaining subsurface oil generally consisted of heavy to light residue (Roberts et al., 1993).

(2) <u>EVOS Shoreline Weathering Adjacent to the Sale 149 Area</u>: The EVOS contacted coastal environments adjacent to the Sale 149 area. Approximately 25 percent of the original spill exited PWS and, of that, 2 percent reached Shelikof Strait (Galt et al., 1991). The nature and consistency of the oil that contacted the Gulf of Alaska and Shelikof Strait coastal environments predominately was a weathered emulsified oil/water/ organic mixture called mousse with some tarry residues (Owens, 1991). In contrast to shorelines in PWS, subsurface migration of oil was limited by the small pore size of the beaches and the viscous consistency of the mousse (Endres and Pavia, 1991; Owens, 1991).

Both the State and Federal Governments and Exxon researched shoreline-oil extent and persistence in Shelikof Strait and along the Alaska Peninsula. Endres and Pavia (1991) indicate overall that the surface oil diminished dramatically between 1989 and 1990 to 1991. Surface coverage was negligible, and the remaining oil was generally sporadic as a result of either localized wave shadowing or an overall low-exposure environment. The persistent mousse oil, which underlies boulders and cobbles at a number of sites, is expected to remain for some time (Endres and Pavia, 1991).

The National Park Service Stranded Oil Persistence Study indicates similar general trends. Beach assessments in 1990, 1991, and 1992 along the Katmai coast documented stranded oil persisting along the high-tide line on stable beaches of moderate to high permeability (Schoch, 1993). Observations of oil-sheen leaching from beaches between 1989 and 1992 indicate that in the relatively sheltered environment of boulder interstices, oil mousse appears to have remained physically and possibly chemically unchanged (Schoch, 1993).

Gilfillan et al. (1993) studied 26 sites in lower Cook Inlet and Shelikof Strait and documented uneven (patchy) oiling levels. Beach assessments in 1989 and 1990 documented a decrease in surface oiling. Concentrations of total polyaromatic hydrocarbons in mussel tissue from oiled sites in Kodiak and the Alaska Peninsula decreased from approximately 2,600 ppb in 1989 to approximately 25 ppb in 1990, but remained above reference levels (Gilfillan et al., 1993).

d. <u>Sale 149 Fate and Weathering</u>: Spills from all three sources—pipelines, platforms, and tankers—are likely to be crude oil but could be fuel oil. Seven of the 11 OCS platform spills ≥1,000 bbl were stored crude or fuel oil.

(1) <u>Sale 149 Open-Ocean Weathering Assumptions</u>: Using the oil-weathering model of Gilfillan et al. (1993), calculations were run for a 50,000-bbl Cook Inlet crude-oil spill for winter and summer for 3, 10, and 30 days to estimate the oil remaining, dispersed, and evaporated and the thickness and area of the slick. Tables IV.A.3-1 and IV.A.3-2 show the oil-weathering-model results. The oil-weathering model of Kirstein, Payne, and Redding (1983) estimates a 50,000-bbl spill of Cook Inlet crude oil in open water of Cook Inlet could physically cover 3 to 7 square kilometers (km^2) of continuous area, and a median spill of 9,300 bbl could cover 1 to 2 km^2 of continuous area (Table IV.A.3-1). A 50,000-bbl spill in broken ice of Cook Inlet physically could cover 2 to 4 km^2 of continuous area, and a median spill of 9,300 bbl could cover 0.5 to 1 km^2 of continuous area (Table IV.A.3-2). Winds, movement of the slick, and other forces would tend to spread the oil discontinuously over an area 20- to 200-fold greater than this actual area of oiled surface. Using the equations of Ford (1985), the discontinuous area of an open-water 50,000-bbl spill could cover 170 to 3,700 km^2 and a broken-ice spill could cover 170 to 3,300 km^2 (Tables IV.A.3-1 and IV.A.3-2). The total sale area is 7,997 km^2. An open-water spill is estimated to cover 2 to 46 percent of the sale area, and a broken-ice spill is estimated to cover 2 to 41 percent of the sale area. Dissolution accounts for approximately 5 percent of slick mass; most spilled oil evaporates, grounds on the shoreline, or eventually forms tarballs or pancakes (Fig. IV.A.3-1). Roughly 35

Table IV.A.3-1
Sale 149 Platform, Pipeline, and Tanker Open-Water Assumed Spill-Size Examples for the Cook Inlet Planning Area[1]

Assumed Spill Size in Barrels[1]	9,300			50,000		
Time After Spill in Days	3	10	30	3	10	30
Winter Spill[2]						
Oil Remaining (%)	58	41	29	65	46	33
Oil Dispersed (%)	16	31	39	12	27	37
Oil Evaporated (%)	24	28	30	23	26	29
Thickness (mm)	0.9	0.4	0.2	1.7	0.8	0.4
Area of Slick (km^2)[3]	0.9	1.3	1.9	2.8	4.5	6.3
Discontinuous Area (km^2)[4]	76	363	1,479	178	851	3,458
Summer Spill[5]						
Oil Remaining (%)	62	43	31	67	49	35
Oil Dispersed (%)	13	27	37	10	22	34
Oil Evaporated (%)	24	29	31	23	27	30
Thickness (mm)	1	0.5	0.2	1.8	0.8	0.4
Area of Slick (km^2)[3]	0.9	1.4	2.0	2.9	4.6	6.6
Discontinuous Area (km^2)[4]	79	380	1,584	190	912	3,715

Source: USDOI, MMS, 1994.

[1] Calculated with the SAI oil-weathering model of Kirstein, Payne, and Redding (1983). These examples are discussed in the Fate and Behavior portion of Section IV.A. The examples are for a Cook Inlet crude type.

[2] Winter (October-March), 16-knot-wind speed, 4.76 °C, 1.8-meter-wave height. Average Weather Marine Area A, Brower et al. (1988).

[3] This is the area of oiled surface.

[4] Calculated from Equation 6 of Table 2 in Ford (1985) and is the discontinuous area of a continuing spill or the area swept by an instantaneous spill of a given volume.

[5] Summer (April-September), 11.5-knot wind speed, 8.8 °C, 1-meter-wave height.

Table IV.A.3-2

Sale 149 Platform, Pipeline, and Tanker Broken Ice Assumed Spill-Size Examples for the Cook Inlet Planning Area[1]

Assumed Spill Size in Barrels	9,300			50,000		
Time After Spill in Days	3	10	30	3	10	30
Winter Spill[2]						
Oil Remaining (%)	58	37	30	65	41	32
Oil Dispersed (%)	34	50	55	38	47	54
Oil Evaporated (%)	8	13	15	7	12	14
Thickness (mm)	1.3	0.52	0.31	2.1	0.92	0.56
Area of Slick (km^2)[3]	0.51	0.83	1.1	1.7	2.8	3.7
Discontinuous Area (km^2)[4]	71	339	1,413	170	794	3,311

Source: USDOI, MMS, 1994.

Table IV.A.3-3

Sale 149 Small Spill-Size Examples for the Cook Inlet Planning Area[1]

Assumed Spill Size in Barrels	5			160		
Time After Spill in Days	3	10	30	3	10	30
Summer Spill						
Oil Remaining (%)	47	32	25	60	42	30
Oil Dispersed (%)	25	37	42	15	30	39
Oil Evaporated (%)	17	29	31	23	27	29
Thickness (mm)	0.67	0.31	0.16	2.5	1.1	0.55
Area of Slick (km^2)[3]	0.06	0.09	0.1	0.6	0.9	1.3
Discontinuous Area (km^2)[4]	1.7	8.8	34	11	48	199

Source: USDOI, MMS, 1994.

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[1] Calculated with the SAI oil-weathering model of Kirstein, Payne, and Redding (1983). These examples are discussed in the Fate and Behavior portion of Section IV.A. The examples are for a Cook Inlet crude type.

[2] Winter (October-March), 16-knot-wind speed, 4.76 °C, 1.8-meter-wave height. Average Weather Marine Area A, Brower et al. (1988).

[3] This is the area of oiled surface.

[4] Calculated from Equation 6 of Table 2 in Ford (1985) and is the discontinuous area of a continuing spill or the area swept by an instantaneous spill of a given volume.

[5] Summer (April-September), 11.5-knot wind speed, 8.8 °C, 1-meter-wave height.

percent of Cook Inlet crude oil would remain after initial weathering in the form of dispersed tarballs or pancakes (Table IV.A.3-1).

(2) Sale 149 Shoreline Weathering:

(a) **Shoreline Type:** The Sale 149 shoreline oil-retention characteristics were surveyed by Michel, Jordana, and Ballou (1986); Domeracki et al. (1983); Ruby et al. (1979); and Michel, Jordana, and Ballou (1986). Using the Environmental Sensitivity Index (ESI), these studies rank the Cook Inlet and Shelikof Strait shorelines in increasing order of sensitivity to oil on a scale from 1 to 10. Gundlach et al. (1990) published a dataset summarizing shoreline characteristics from the above reports into seven ESI types for Cook Inlet/Shelikof Strait: (1) rocky shore; (2) gravel/cobble/boulder beach; (4) sandy beach; (5) mixed sand and gravel beaches; (6) tidal flat; (7) marsh; and (8) lagoon. The kilometers of each shoreline type from 1 through 8 are calculated for land segments (LS's) 1 through 54 and 64 through 96 divided into four regions shown in Figure IV.A.3-3. In the total coastal environment adjacent to the Sale 149 area, approximately 49 percent is sheltered/exposed rocky shores and wave-cut platforms; 31 percent is mixed sand and gravel beaches; 12 percent is gravel beaches; and <7 percent is sand beaches, tidal flats, and marshes (Gundlach et al., 1990).

(b) **Sale 149 Shoreline-Oil Persistence:** Stranded-oil persistence results from oil remaining after cleanup or where cleanup may cause more environmental damage than if the oil were left in place. The coastal environments adjacent to the Sale 149 area are similar to the coastal environments contacted by EVOS in PWS and the Gulf of Alaska. Therefore, shoreline-oil persistence and weathering in PWS provides an analogy for how oil will weather if an oil spill contacted the coastal areas adjacent to the Sale 149 area. However, Cook Inlet and Shelikof Strait have more wave exposure and energy, which may accelerate weathering processes.

Some of the coastal environments adjacent to the Sale 149 area were previously oiled from the EVOS as discussed above. Reoiling from another spill would affect oil persistence and weathering.

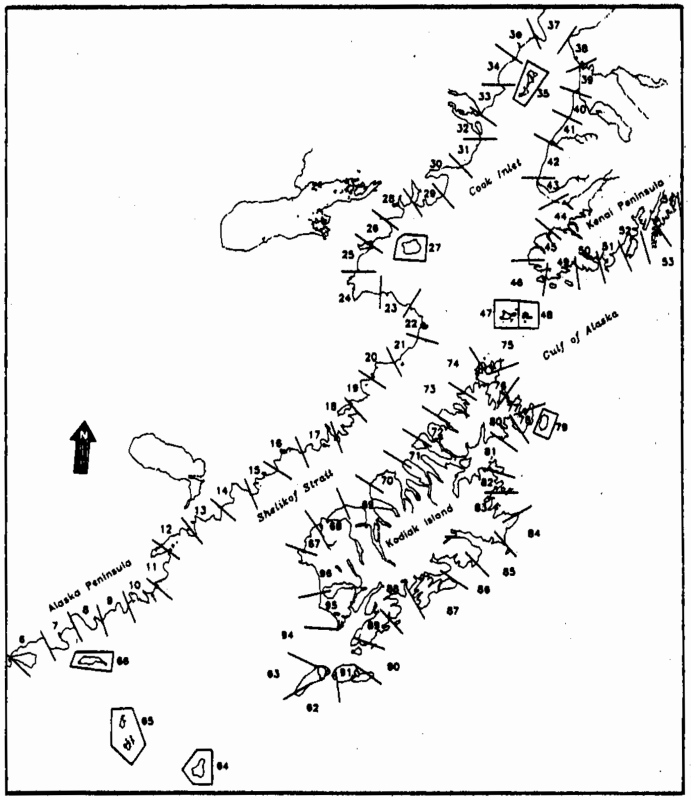
The coastal environment adjacent to the Sale 149 area has approximately 49-percent exposed rocky shore. The ESI predicts short-term effects for exposed rocky shores. During the EVOS, most exposed rocky shorelines showed little to no oil persistence besides staining and scattered tar blotches (Gundlach et al., 1990). On a small scale, however, these rocky shorelines are indented and fractured, creating numerous pockets. Some rocky shorelines are sheltered from wave and wind direction. On some exposed rocky shores sheltered to wind and waves, heavy oil concentrations were found 8 months after the EVOS (Gundlach et al., 1990).

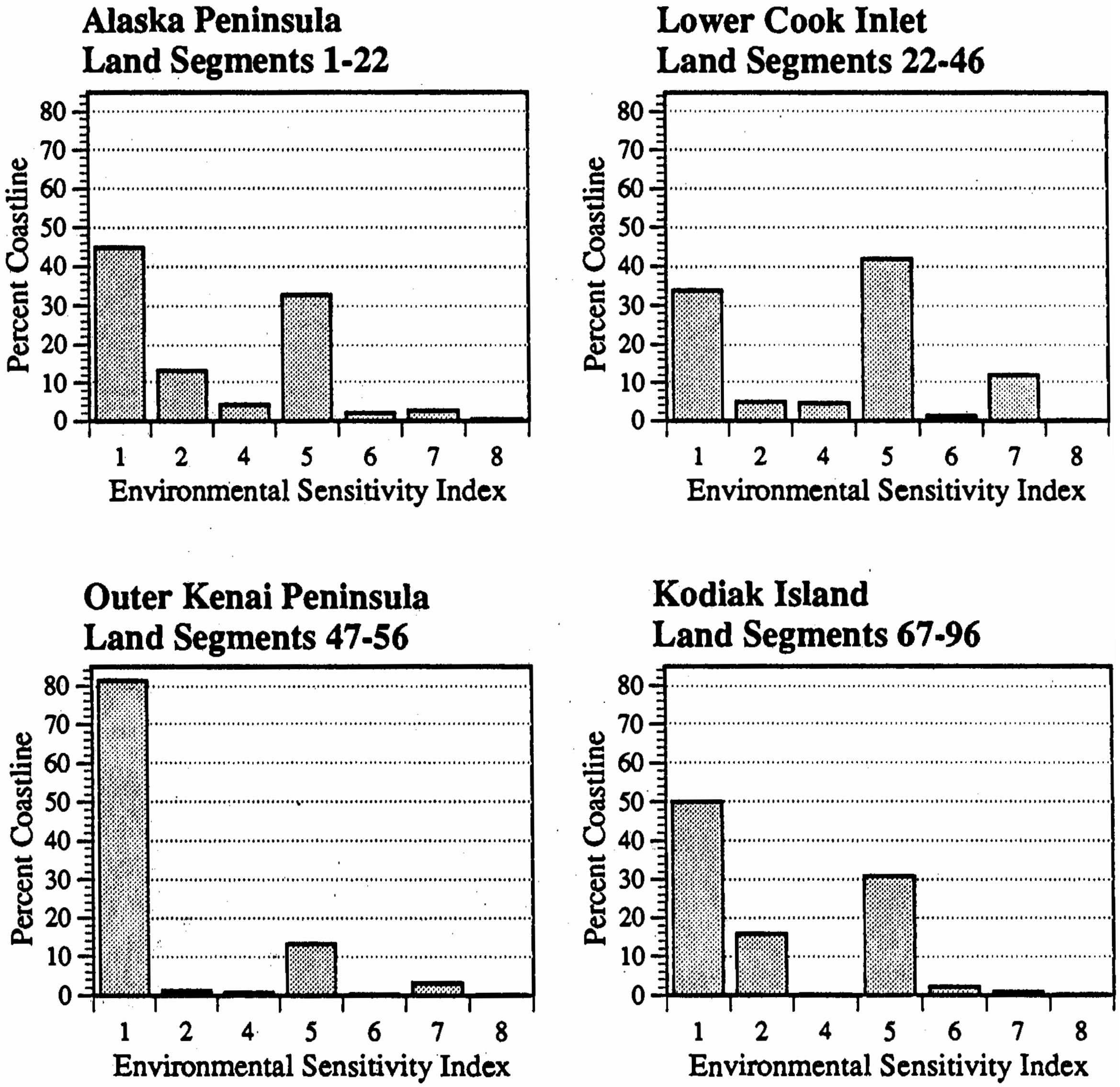
The Sale 149 area has about 31-percent mixed sand and gravel beaches and 12-percent gravel beaches. The ESI predicts oil mixing deeply (<10 centimeters [cm] up to a meter [m]) in well-sorted sand and gravel and gravel material and especially deep burial along the berm. Mixed sand and gravel beaches were a shore type affected from the EVOS (Gundlach et al., 1990). Gravel beaches pose a special problem due to the potential for deep oil burial and the persistence of subsurface oil for decades (Hayes, Michel, and Noe, 1991; Michel et al., 1991; Michel and Hayes, 1993a, 1993b; Owens, 1991, 1993). Gravel beaches enhance oil accumulation through burial by accretion features and the formation of asphalt pavement, and the armoring of the gravel beach impedes erosion (Hayes, Michel and Noe, 1991; Michel and Hayes, 1993a, 1993b).

The Sale 149 area has approximately 2 percent coarse-grained-sand beaches. The ESI predicts oil deposition primarily high on the beach face and potential deep burial along the berm. Oil persistence depends on the wave energy, with sheltered areas harboring oil for years. The ESI predicts longer persistence on coarse- rather than fine-grained-sand beaches. On fine-grained-sand beaches in Katmai, oil remained on or near the surface (Gundlach et al., 1990). Clay-oil flocculation is identified as a process on fine-grained-sand beaches that accelerates weathering and prevents asphalt-pavement formation, thereby reducing oil persistence (Bragg and Yang, 1993).

Exposed tidal flats make up approximately 3 percent of the Sale 149 area. The ESI predicts that most oil would be pushed across the tidal flat onto adjacent shores. The high sensitivity rating is due to the biological components using the tidal flat. Coarse cobbles on the tidal flat can cause oil to persist for several months (Gundlach et al., 1990).

Adjacent to the Sale 149 area, <1 percent is marshes. This coastal environment has the highest ESI ranking of 8. The ESI predicts long-term persistence for marshes due to the sheltered nature of the shoreline or the fine-grained





Environmental Sensitivity Index Shore Type

1 Rocky Shore
2 Gravel/Cobble/Boulder Beach
4 Sandy Beach
5 Mixed Sand and Gravel Beach
6 Tidal Flat
7 Marsh
8 Lagoon

Increasing Sensitivity →
1 2 3 4 5 6 7 8

Source: Data compiled from Gundlach et al. 1990.

Figure IV.A.3-3. Percent of Coastline with Environmental Sensitivity Indexes 1 through 8 for the Alaska Peninsula, Lower Cook Inlet, Outer Kenai Peninsula, and Kodiak Island.

sediments. The EVOS data indicate long-term persistence (Gundlach et al., 1990).

(c) **Estimated Sale 149 Shoreline Oil Contact and Occurrence and Contact**: Conditional risk-contour maps of 30-day, summer- and winter-conditional probabilities (expressed as percent chance) show that land segments on western Cook Inlet are exposed to (1) higher chances of contact, (2) potential contact from more lease blocks, and (3) contacts from lease blocks farther away than land on eastern Cook Inlet (Johnson et al., 1994).

The estimated conditional probabilities (expressed as percent chance) of contact to individual land segments after 30 days from hypothetical pipeline segments T1, T2, and P1 to P5 range from <0.5 to 26 percent during summer and from <0.5 to 28 percent during winter (Appendix B, Tables B-10 and B-13). The estimated conditional probabilities (expressed as percent chance) of contact to land segments after 30 days from hypothetical tanker segments T1 to T8 range from <0.5 to 25 percent during summer and from <0.5 to 28 percent during winter (Appendix B, Tables B-10 and B-13).

Combined probability (expressed as percent chance) of one or more spills ≥1,000 bbl contacting the environmental resource land (all land segments) is 26 and 70 percent, respectively, for the base and high case after 30 days (Fig. IV.A.2-8 and Appendix B, Table B-14).

For the base case, the OSRA estimates annual combined probabilities (expressed as percent chance) ranging from a 1- to 2-percent chance of one or more spills ≥1,000 bbl occurring and contacting 19 land segments after 30 days (Fig. IV.A.3-4). Those land segments are LS's 19 and 21 (western shore of upper Shelikof Strait), LS 22 (Cape Douglas), LS's 23 to 29 (Kamishak Bay, Augustine Island), LS's 30 to 33 (Chinitna Bay to Tuxedni Bay), LS 35 (Kalgin Island), LS 40 (Clam Gulch to Cape Kasilof), LS's 42 and 44 (Anchor Point to Ninilchik and Kachemak Bay), and LS 47 (Ushagat Island).

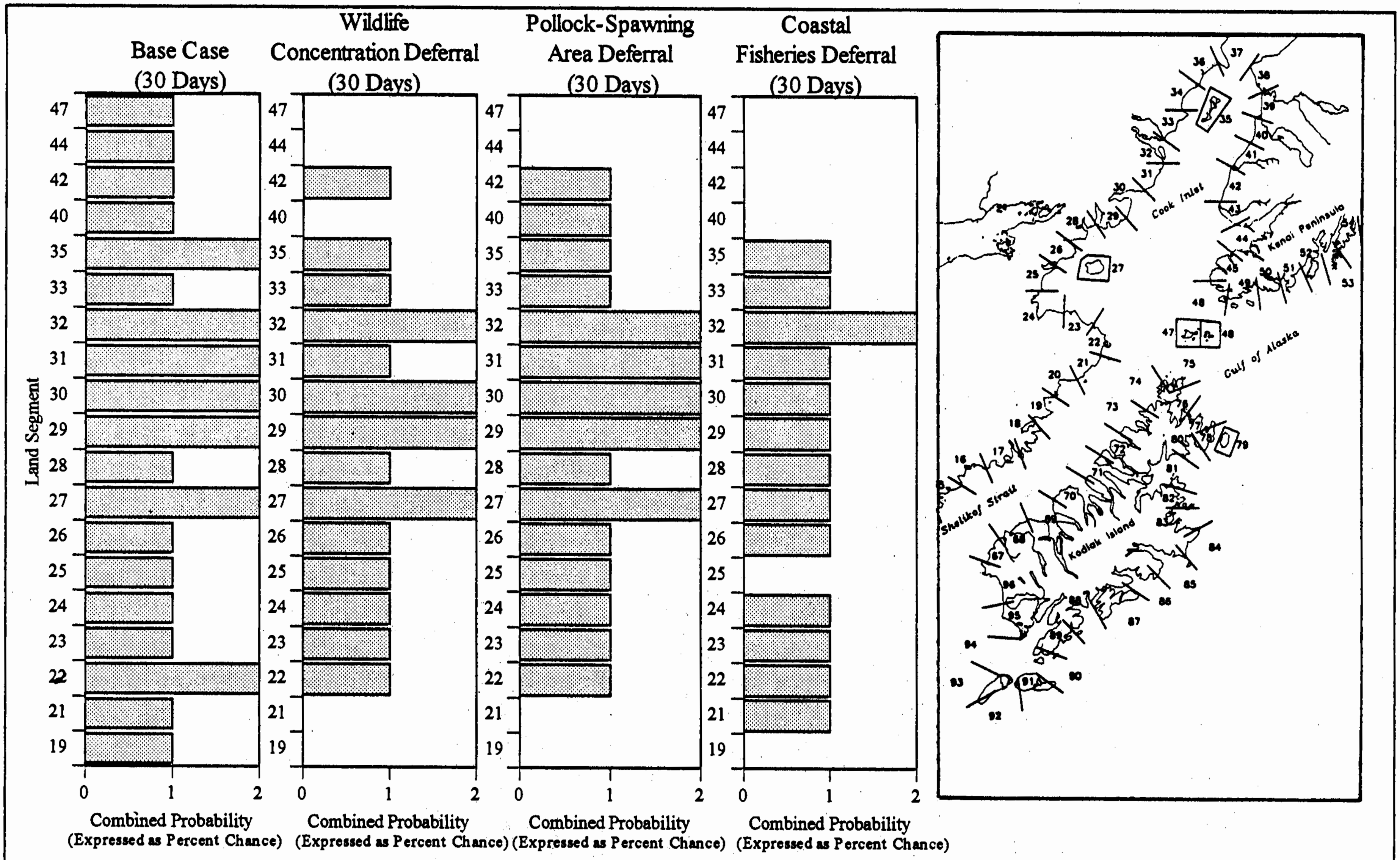
For the high case, the OSRA estimates annual combined probabilities (expressed as percent chance) ranging from a 1- to 9-percent chance of one or more spills ≥1,000 bbl occurring and contacting 34 land segments after 30 days (Fig. IV.A.2-8). Those land segments are LS's 18 to 22 and 73 to 77 and 79 (Shuyak and Afognak Islands and western shores of Shelikof Strait), LS's 23 to 29 (Kamishak Bay, Augustine Island), LS's 30 to 33 (Iniskin Bay to Redoubt Bay), LS 35 (Kalgin Island), LS's 38 to 46 (East Forelands to Elizabeth Island on Eastern Cook Inlet), and LS's 47 and 48 (Barren Islands).

For the Wildlife Concentration Deferral Alternative, the OSRA estimates annual combined probabilities ranging from a 1- to 2-percent chance of one or more spills ≥1,000 bbl occurring and contacting 14 land segments after 30 days. In comparison with the base case where the chance of spill occurrence and contact is 1 percent, LS's 19 and 21 (upper western Shelikof Strait), LS 40 (Clam Gulch to Cape Kasilof), LS 44 (Kachemak Bay), and LS 47 (Ushagat Island) have a <0.5-percent chance of spill occurrence and contact (Fig. IV.A.3-4).

For the Pollock-Spawning Area Deferral Alternative, the OSRA estimates annual combined probabilities ranging from a 1- to 2-percent chance of one or more spills ≥1,000 bbl occurring and contacting 15 land segments. In comparison with the base case, where the chance of occurrence and contact is 1 percent, LS's 19 and 21 (upper western Shelikof Strait), LS 44 (Kachemak Bay), and LS 47 (Ushagat Island) have a <0.5-percent chance of occurrence and contact (Fig. IV.A.3-4).

For the Coastal Fisheries Deferral Alternative, the OSRA estimates annual combined probabilities ranging from a 1- to 2-percent chance of one or more spills ≥1,000 bbl occurring and contacting 15 land segments. In comparison with the base case, where the chance of contact and occurrence is 1 percent, LS 19 (upper western Shelikof Strait), LS 25 (Chenik Head to Bruin Bay), LS 40 (Clam Gulch to Cape Kasilof), LS 42 (Anchor Point to Ninilchik), LS 44 (Kachemak Bay), and LS 47 (Ushagat Island) have a <0.5 percent chance of occurrence and contact (Fig. IV.A.3-4).

For the Northern Deferral Alternative, the OSRA estimates annual combined probabilities ranging from a 1- to 2-percent chance of one or more spills ≥1,000 bbl occurring and contacting 15 land segments. In comparison with the base case, where the chance of occurrence and contact is I percent, LS 40 (Clam Gulf of Kasilof), LS 42 (Anchor Point to Ninilchik), LS 44 (Kachemak Bay), and LS 47 (Ushagat Island) have a <0.5-percent chance of occurrence and contact.



Note: All land segments with all values <0.5 combined probability (expressed as percent chance) are not shown on this graph. Land segments with no bars have <0.5 combined probability (expressed as percent chance).

Source: Appendix B, Tables B-14 and B-15.

Figure IV.A.3-4. Estimated Combined Probabilities (expressed as percent chance) That One or More Oil Spills Greater Than or Equal to 1,000 Barrels will Contact a Certain Land Segment over the Estimated Lifetime of the Proposal.

For the Kennedy Entrance Deferral, the chance of occurrence and contact is similar to the base case. The differences in the chance of contact between the base case and the Kennedy Entrance Deferral Alternative are discussed in Section IV.A.2.a.(5).(b).

4. **Aspects of Spill Prevention and Response**: The petroleum industry and government have separate responsibilities for oil-spill prevention, contingency planning, and response. The MMS has established stringent requirements for spill prevention and response and employs an inspection program to ensure industry compliance. To complement the regulatory programs in place, the petroleum industry uses state-of-the-art technology for prevention equipment and the most current operating procedures while conducting operations on the OCS. Additionally, the petroleum industry must maintain a constant state of readiness for oil-spill response to meet the MMS's stringent response requirements. If an oil spill should occur, it is the responsibility of the spiller to respond to the spill with the oversight of the Federal and, depending on the location of the spill, State Governments. The Federal Government's role during an oil spill has been restructured and expanded by the Oil Pollution Act of 1990 (OPA 90). Implementation of these changes is expected upon promulgation of the new National Contingency Plan. Further details are provided in Section IV.A.4.c(6).

a. **Prevention:**

(1) **Exploration**: By the close of 1993, 81 exploratory wells were drilled on the Alaskan OCS, including 13 in the Cook Inlet and Shelikof Strait. A total of 12.8 bbl of crude and refined oil were spilled from these drilling activities. There were no blowouts or spills resulting from the loss of well control. The relatively small amount of oil spilled while drilling the 81 wells may be attributed to MMS's comprehensive regulations for preventing spills from drilling operations on the Alaskan OCS and the petroleum industry's commitment to clean and safe operations.

Specific regulations covering exploratory operations are found in 30 CFR 250, Subsections B and D, which cover exploration and drilling operations, respectively. The MMS regulations incorporate numerous industry Standards, Recommended Practices, and Technical Specifications that outline standard engineering practices and procedures adopted by the petroleum industry. The MMS prevention program begins when the Exploration Plan (EP) is submitted.

The purpose of the EP is to provide the Government and the public with general information about the proposed exploration program. The EP contains general information pertaining to the operator's overall drilling plan and is reviewed by the MMS; the public; and other State, Federal, and local government organizations. If the EP meets MMS requirements, it may be approved. The MMS prepares an Environmental Assessment on each EP. If major environmental effects are identified that are not addressed by existing regulatory requirements, the MMS may restrict the activity or adopt additional mitigation. No exploratory drilling may be conducted unless an EP has been approved and deemed consistent with the Alaska Coastal Zone Management Plan. The EP may describe single well or multiwell drilling programs that are contingent on the results of each subsequent well. The EP outlines the scope of the proposed activities as well as the equipment, personnel, and a general timeline to be used for the drilling operation. An analysis of the potential environmental effects likely to occur during the drilling operations also is presented in the EP. In general, the EP provides the MMS and the public the information necessary to ensure that the operator will use the appropriate equipment and trained personnel to safely conduct the drilling operation and to determine if the activity will have any significant environmental effects. An Oil Spill Contingency Plan (OSCP) is submitted as supporting information for the EP. The OSCP provides information pertaining to the operator's planned response should an oil spill occur from the drilling operation. The OSCP includes information on site- or situation-specific oil-spill-response strategies, equipment, trained personnel, and the logistical support necessary to conduct a spill response.

Before any drilling can begin, the operator must submit an Application for Permit to Drill (APD) to the MMS. The APD may be submitted before, during or after submission of the EP but may not be approved until an EP has been approved and deemed consistent with the Alaska Coastal Management Program.

The APD outlines a drilling plan specific to a single well and provides proprietary geologic and engineering information. The APD is reviewed by MMS petroleum engineers, geologists, and geophysicists to ensure that all drilling operations meet MMS's stringent requirements and are conducted in an environmentally sound manner. The APD includes well-specific information such as casing, cementing and mud programs, well-control-equipment-operating limitations, expected pressure gradients, surface and bottomhole locations, drilling-unit-operating limitations, shallow-hazards data, and other engineering and geologic information. Site-specific seismic and geologic information is analyzed to determine the presence of shallow hazards (i.e., shallow gas, faulting, and other such hazards). The APD includes a Critical Operations and Curtailment Plan that describes the procedures for shutting down operations prior to environmental conditions that approach the operating limitations of the drilling unit.

Once the EP and APD are approved, MMS's exploratory permit requirements are fulfilled and the operator may begin drilling. It should be noted that there are numerous additional State (depending on the location of the drill site) and Federal permits that require approval before drilling may begin.

Once drilling is under way, the MMS monitors operations through daily drilling reports and onsite MMS activities inspection. If the operator determines the need to deviate from the plans described in the APD, a sundry notice, which contains detailed engineering information pertaining to the proposed changes, must be submitted to the MMS for review and approval.

Offshore exploratory wells are generally only used for exploration and, therefore, require abandonment once the operator has extracted all the necessary information. When the well is ready for abandonment, the operator must submit an abandonment plan to the MMS. Abandonment plans outline well-specific procedures to abandon the well so that permeable formations are isolated with cement plugs to prevent potential formation fluid (oil, gas, or water) migration to the surface.

The MMS also requires that drilling personnel successfully complete an MMS-approved well-control training course. The courses are designed to ensure all drilling personnel understand and can detect signs of potential well-control problems as well as the actions necessary to prevent loss of well control. As an additional preventative measure, the MMS requires complete redundancy in Blow Out Prevention (BOP) equipment. The MMS also requires the BOP equipment to be actuation and pressure tested on a regular basis to ensure its integrity. To reduce the likelihood of the loss of well control, the MMS requires the operator to conduct specific procedures for monitoring the mud system during activities that are known to have a high kick (influx of formation fluids into the well bore) occurrence rate.

(2) Production, Workover, and Pipelines: The EP process ends once a discovery has been made and delineation drilling is complete. Before any production facilities or platform may be placed on the OCS, the designated operator must prepare and submit a Development and Production Plan (DPP). Similar to an EP, the DPP includes information on potential environmental effects and an activity-specific OSCP. The DPP must undergo a public-review process and a separate environmental review by the MMS. The OCS Lands Act also requires that at least one DPP in a frontier area, which would include the Sale 149 area, be subject to a complete EIS. Every development well is required to have an approved APD prior to being drilled. Although no production, workover, or pipeline operations currently exist on the Alaskan OCS, the MMS has extensive regulatory experience for offshore production in both California and the Gulf of Mexico. The MMS regulations for preventing spills from production operations are found in 30 CFR Part 250 Subsections E, F, H, and J. The regulations cover completion, workover, production, and pipeline operations, respectively. To make the regulations as comprehensive as possible, the MMS has incorporated by reference numerous industry Standards, Recommended Practices (RP), and Technical Specifications. Primary among the American Petroleum Institute (API) documents for prevention is API RP 14C, Recommended Practice for Analysis, Design, Installation, and Testing of Basic Surface Safety Systems for Offshore Production Platforms.

A platform-surface-safety system is a group of safety devices that are intended to automatically detect and prevent the occurrence of common production-system hazards and, thereby, protect the facility, personnel, and environment from injury. The major threat to safety on a production platform is the release of hydrocarbons. Thus, the analysis and design of a production-platform-safety system must focus on preventing hydrocarbon releases by stopping their flow to a leak, thereby minimizing the volume of hydrocarbons that are released. To accomplish this, safety systems use protection concepts to prevent the occurrence of undesirable events. An undesirable event is an adverse occurrence in a process component that may result in the accidental release of hydrocarbons. There are five undesirable events around which the surface-safety system is designed: (1) Overpressure. An overpressure condition occurs when the pressure in a process component exceeds the normal operating pressure range. (2) Leak. A leak occurs following a breach in a process component resulting in an accidental escape of oil, water, and/or gas to the atmosphere. (3) Liquid Overflow. A liquid overflow occurs when the accumulation, of liquid within a process component becomes greater than the design accumulation causing a discharge of liquids through a gas or vapor outlet. (4) Gas Blowby. Gas blowby occurs when the liquid level within a process component becomes less than the design accumulation, causing a discharge of gas from a process component through a liquid outlet. (5) Underpressure. Underpressure occurs when the pressure in a process component becomes less than the design collapse pressure, causing the process component to collapse.

Because the undesirable events may occur, the production-safety system is designed to prevent them, isolate the problem to minimize or prevent the effect, contain any spillage, and shut in the process in the event of a fire. The platform-safety system provides two levels of protection to prevent or minimize the effects of an equipment failure within the process. The two levels of protection are independent of and in addition to the control devices used in the normal process operation. In general, these two levels of protection are provided by different types of safety devices and give a broader spectrum of coverage for the five commonly occurring undesirable events. These protective measures are common industry practices and are proven through many years of experience.

In a production safety system, undesirable events are detected by various types of sensors that initiate a shutdown action to prevent or limit the release of hydrocarbons from a well or process component. These sensors are installed on the specific well or process vessel or as part of the Emergency Support System (ESS). The ESS includes: (1) the combustible gas detection system to sense the presence of escaped hydrocarbons and to initiate alarms and platform shutdown before gas concentrations reach the lower explosive limit; (2) the containment system to collect escaped liquid hydrocarbons and to initiate platform shutdown; (3) the fire-loop system to sense the heat of a fire and to initiate platform shutdown; (4) the Emergency Shutdown System (ESD) to provide a method to manually initiate platform shut down by personnel observing abnormal conditions or undesirable events; and (5) the subsurface safety valves, which may be self-actuated or actuated by an ESD system and/or a fire-loop system located within the wellbore of every well.

Prior to installation of the production-safety system, the MMS must review and approve the plans. To ensure proper installation and the functionality of the system, the MMS conducts a preproduction inspection to test each of the safety devices prior to allowing production to commence.

(3) **The MMS Inspection Program**: The MMS inspection program plays an integral role in the prevention of oil spills. The program is designed to provide effective monitoring and enforcement of operator compliance with the requirements set forth in the OCS Lands Act, applicable Federal laws and regulations, lease terms, conditions of permit approval, and other directives. Compliance is ensured through a rigorous inspection program that uses comprehensive inspections before, during, and after commencement of drilling operations. The MMS uses an inspection staff composed of highly trained technicians and engineers to implement this multifaceted inspection program.

Prior to the use of a drilling unit that previously has not been approved for use on the Alaskan OCS, the drilling unit must undergo a rigorous inspection to ensure compliance with MMS regulations. The MMS technicians inspect electrical systems, BOP systems, ventilation systems, alarm systems, and other safety and prevention systems to ensure compliance with MMS regulations. Any system found not in compliance must be corrected prior to commencement of drilling operations.

For exploratory drilling operations in Alaska, inspectors witness operations critical to the safety and stability of the well, including but not limited to cementing; blowout drills; and pressure-testing blowout preventers, chokes, and diverters. In addition to witnessing such operations, inspectors conduct detailed and partial inspections using the Potential Incident of Non-Compliance (PINC) checklist.

The PINC lists are composed of items the inspector must examine to ensure that the operator is complying with the regulations, lease stipulations, and permit conditions. Partial inspections are completed on a daily basis, provided the inspector remains on the drilling unit for more than one consecutive day, and consist of inspecting items on the partial PINC list. Detailed inspections are generally conducted on a weekly basis and use the detailed PINC list as well as special PINC lists specifically generated for each operation. In addition to inspecting for compliance with MMS requirements, MMS inspectors, under a Memorandum of Agreement with the Environmental Protection Agency (EPA), conduct inspections for compliance with EPA's National Pollutant Discharge Elimination System permits for operational discharges.

In the event of a commercial discovery and subsequent development and production, the MMS, Alaska OCS Region, would develop an inspection strategy commensurate with the scope and nature of the activities as well as the operating environment.

b. Oil-Spill-Contingency Measures: The goal of the MMS oil-spill program is to ensure that the lessee is prepared to respond to any size spill—from a small operational spill to a large worst-case spill. To achieve this goal, MMS requires oil-spill-contingency plans for all operations. Further, MMS uses inspections, equipment deployment, and tabletop-communication exercises to ensure that the lessee has trained, knowledgeable crews and well-maintained equipment to respond to a spill.

(1) Contingency Plans: Before conducting exploratory drilling operations, MMS's oil-spill regulations (30 CFR 250.42) require each lessee to submit an OSCP to the Regional Supervisor, Field Operations, MMS, for approval with, or prior to, the submission of an exploration or development and production plan. The OSCP is developed for the site-specific operations, based on the type, timing, and location of the proposed activities. The OSCP must satisfy the content requirements and provisions identified in 30 CFR 250.42 and the *Planning Guidelines For Approval of Oil Spill Contingency Plans* developed jointly by the MMS and U.S. Coast Guard (USCG).

(2) Applicability of Oil-Spill-Response Technology in the Sale 149 Area: The technical capability to contain and clean up offshore oil spills from activities in the Sale 149 area depends on the oil type; amount of oil spilled; and the sea, ice, and meteorologic conditions during the response effort. The sale area is noted for its high winds, currents, large tidal range, and the presence of moving, broken ice. Although it is expected that a large portion of any spill could be recovered, burned, or dispersed, it is not likely that all the oil would be removed. In any spill response, spill detection and tracking are extremely important so that spill-response planners may devise and refine a response strategy.

(a) Detection and Tracking: There are a number of methods and devices that may be used in the Sale 149 area for spill detection and tracking. Among the most widely used and relatively low cost is visual detection by trained personnel from onboard a drilling structure, watercraft, or spotter aircraft. Oil usually is visible from the air, although its appearance has wide variations in color depending on the thickness of the slick, the viewing angle and altitude, and light conditions. To the untrained eye, naturally occurring events such as pollen, seaweed, cloud shadows, and ocean-surface ripples may be confused with oil slicks. Additionally, oil may be difficult to visually detect on dark-colored shorelines and when mixed with biogenic materials. Sophisticated remote-sensing equipment that can discern the differences between naturally occurring anomalies and oil slicks are available and commonly used to enhance the information gathered by visual means.

Remote-sensing systems include still and video cameras, scanners, infrared sensors, ultraviolet and fluoro-sensors, radar, microwave and satellite imagery. There are a number of remote-sensing systems currently available. The USCG, the U.S. Government entity with primary responsibility during an offshore-spill response, maintains an aircraft-deployed oil-spill-surveillance system known as the "Aireye." The Aireye is an airborne, real-time, all-weather, day/night, remote-sensing system. The Aireye system's primary sensor is a Side Looking Airborne Radar with an oil-slick-detection range of 15 to 25 mi. Other Aireye sensors include infrared/ultraviolet scanners and an aerial-reconnaissance camera and low-light-video equipment. In a large-spill event, it is likely this system would be used to detect the extent of the oil.

In addition to remote sensing, real-time-tracking and -trajectory modeling are extremely important tools for monitoring spill movement and for spill-response planning. Spill-tracking buoys that are designed to move with the oil are commercially available. The spill-tracking buoys use either a radio-tracking device or a satellite to detect their position. The buoys are deployed in the leading edge of the slick and used to monitor spill movement and to determine resources that may be at risk. Real-time-trajectory models such as the National Oceanic and Atmospheric Administration's (NOAA's) Oil Spill Simulation Model may also be used in the Sale 149 area to determine what resources are at risk and target areas for the most efficient use of spill-response equipment. Once the spill is located, spill-specific-containment and -recovery operations may be planned and initiated.

(b) Containment and Recovery: Mechanical oil-spill response generally is accepted as the primary means for containing and recovering an oil spill. Equipment employed in a mechanical response generally consists of boom for spill containment; skimmers for spill recovery; and vessels to tow the boom, act as operating platforms, and store the recovered oil and water.

The purpose of containing spilled oil is to prevent spreading and to concentrate the oil for more efficient mechanical recovery or in situ burning operations. Oil-spill-containment booms are the primary tool used for offshore containment during open water or limited broken ice conditions (less than approximately 25% ice coverage). Booms are classified according to their containment capabilities. Calm-water booms can be used to contain oil through an International Sea State of 1 (significant wave height to 1 ft), harbor booms through an International Sea State of 2 (significant wave height to 2.9 ft), and offshore booms with some success through an international sea state of 4 (significant wave height to 6.9 ft). Other booms are categorized by their special use, such as sorbent booms, fire-resistant booms, and ice-deflection booms. For operations in the Sale 149 area, industry would be expected to maintain or have available state-of-the-art offshore-containment boom as well as an offshore fire-resistant containment boom for in situ burn operations.

Recovery is defined as the mechanical removal of oil from the shoreline, water, or ice environment. For oil on water, recovery techniques can be divided into two groups: the use of skimmers and the use of sorbents. Because in situ burning is not generally regarded as a recovery technique, it is discussed separately.

Sorbents are made of oleophillic materials designed to absorb up to 30 times their weight in oil. Sorbents are available in a number of forms and are primarily used to recover small oil spills and films from the water surface. Other sorbent applications include spill recovery in small melt pools, on shorelines, and around industrial equipment; they also have been used to recover burn residue after in situ burn testing. It is expected that sorbents would be used, as described above, in the Sale 149 area.

Skimmers are mechanical devices designed to float on the surface of the water and recover oil. They are generally categorized as suction devices, weir devices (blocking the water so oil flows over the top), centrifugal devices, oleophillic (the oil adheres to the material), and hybrid devices (hybrid devices use a combination of the above principles). The effectiveness of a skimmer depends on the characteristics of the oil, slick thickness, oceanographic conditions (especially sea state), oil-encounter rate, throughput efficiency, and recovery efficiency. As a general rule, optimum efficiency is reached when the slick is thick and the sea is calm. Increasing the oil's viscosity, the amount of debris encountered, and/or the sea state reduces the effectiveness of the skimmer causing increased water recovery and down time. Local oil-spill cooperatives, such as the Cook Inlet Spill Prevention and Response, Inc., maintain a number of each type of skimmer. In the event of a large spill in open water or limited broken ice, any or all such skimmers would be expected to be used in the Sale 149 area.

(c) **In Situ Burning:** In situ burning is defined as the burning of oil on the surface of the water in situ (in place). Because of the high removal rate and efficiency of this technique, it is becoming more widely accepted as a response technique. Additionally, industry has almost unanimously adopted in situ burning as a primary technique for responding to large oil spills that occur in broken-ice conditions. In situ burning also has been demonstrated to be an extremely useful spill-response tool in open water with the use of fire-resistant containment boom. The effectiveness of the technique has been demonstrated in the laboratory, test tanks (Evans et. al., 1992), and in the field during the *Exxon Valdez* spill (Allen, 1991). Because of the validity of this response tool the Alaska Regional Response Team (ARRT) has provided conditional preapproval for the Federal On-Scene Coordinator (FOSC) to approve in situ burning in the Cook Inlet, Prince William Sound, and the Beaufort Sea. While the effectiveness of in situ burning is generally accepted, there remain some unanswered questions regarding the tradeoff of air quality versus potential shoreline/biologically sensitive area contamination from the slick. The MMS, in conjunction with Environment Canada and others, is continuing research to quantify this tradeoff (Evans et. al., 1992).

In situ burning likely would be used for a large spill in the Sale 149 area because it greatly reduces the need for recovery, storage, transportation, and disposal of spilled oil and it is effective and efficient (Allen and Ferek, 1993). Additionally, suitable equipment is in place as well as the avenue for approval of in situ burning. However, until additional information is available concerning the transport of the smoke plume, this technique is not likely to be used if the trajectory of the smoke plume is predicted to move toward populated areas depending on the distance away from said populated area.

(d) **Dispersants and Other Chemicals:** The term "chemical agents" is an all-encompassing term that describes chemicals that may be used during an oil-spill response. Numerous chemical agents have been commercially produced and sold over the past two decades. These chemical agents include dispersants, gelling agents, emulsion breakers and preventers, biodegradation agents, and several other miscellaneous products.

Dispersants are chemical agents that contain surfactants for breaking up oil into small droplets in the water column. They are the most common of all the chemical agents available for spill response. Dispersants decrease the interfacial tension between the oil and the water, thus reducing the cohesiveness of the slick. Aided by wind and waves, the oil is dispersed into the water column in the form of small droplets. Breaking the slick into small droplets increases the surface area available for natural degradation and reduces the concentration of the oil. Dispersants are not widely accepted, despite their claimed benefit, primarily because of biological concerns and because their effectiveness has not been proven in field trials or actual spill events. The ARRT has conditionally preapproved the use of dispersants in the Cook Inlet and Prince William Sound areas. Such a preapproval permits the FOSC to authorize dispersant use without first receiving ARRT approval, depending on the area proposed for application. Because of the availability of equipment and dispersants and the avenue for approval, it is likely that a dispersant-test application would be approved and conducted in the event of a large spill. If the test is proven effective, further application may be approved.

Gelling agents, emulsion breakers, oil herders, and several other chemicals have been marketed for spill response but are not widely used during offshore spill responses. None are currently anticipated for use in the event of a large spill in the Sale 149 area.

(e) **Shoreline Response:** If a large spill occurred in the Sale 149 area, some shoreline contacts are estimated. The techniques for removing oil from shorelines in Alaska are varied and have been effectively demonstrated in Prince William Sound during the *Exxon Valdez* spill. It should be noted here that a number of the techniques used in Prince William Sound are thought to have caused more damage than the oil itself (Driskell et al., 1993). It is expected that some less damaging techniques would apply and be used in the Sale 149 area if a spill were to contact the shoreline. The specific techniques used for any given oiled shoreline will depend on the physical properties of the oil, the extent of shoreline oiling, environmental conditions, the type of shoreline to be cleaned, and the logistical requirements. In general, the shoreline response methods expected to be used in the Sale 149 area include direct suction, small skimmers for pooled oil, the use of sorbent material, cool- and warm- high- and low- pressure water flushing, direct removal of contaminated material and sediments, mixing/aeration of oiled sediment, burning, bioremediation, chemical treatment, and natural degradation (i.e., no response where cleanup action would cause more damage than the oil itself).

(f) **Storage/Disposal:** An important consideration for both planning and executing an oil-spill response is the interim storage and disposal of recovered oil and oil-contaminated debris. While recovered oil and oil-contaminated debris may be stored in small collapsible containers that are normally stored as part of the onsite equipment, the problem becomes much larger as the spill size increases. For larger spills, limited storage is available on work boats and drilling units as well as on any of the numerous barges available in the region. (Cook Inlet Spill Prevention and Response, Inc. [CISPRI] maintains a barge at Nikiski, Alaska, for spill response in the region.) If no storage is available on the above listed- vessels, flexible bladder-type tanks are available from local cooperatives and may be in the inventory of the lessee's onsite-spill-response equipment. For extraordinary spills, such as the *Exxon Valdez* spill, additional barges could be moved to the Sale 149 area from other areas of Alaska to facilitate the necessary storage.

Once the oil and debris are collected, disposal options include the use of incinerators, flare burners, as well as transport to refineries for fluid processing or landfills approved to accept oily waste. Currently, there are no incinerators or disposal sites approved in Alaska that can accept large amounts of oil or oily debris. If the landfill-disposal option is chosen, the oily debris would be transported to an approved disposal site on the west coast of the contiguous United States. During the *Exxon Valdez* spill, Exxon moved a barge-mounted incinerator into Alaskan waters to burn oily debris but was unable to obtain the necessary air-quality permits to operate the incinerator. Because all of the storage and disposal options apply to the Sale 149 area, any or all could be used in the event of a spill.

c. Oil-Spill Response

(1) **Locally Available Spill-Response Equipment:** In addition to the equipment that the MMS, Alaska OCS Region, requires to be available at the site of operations, local oil-spill-response cooperatives may provide spill-response equipment. The Alaska OCS Region policy requires that spill-response equipment be staged at the site of operations in sufficient quantities to respond to a small operational spill as well as provide an initial response for a worst-case spill until additional response equipment arrives at the site.

Three oil-spill cooperatives located in Alaska have equipment inventories for mechanical, dispersant, and in situ burning responses. All of the oil-spill cooperatives listed in this section have substantially increased their equipment inventories since the *Exxon Valdez* ran aground in March 1989. Additionally, both Alaska Clean Seas (ACS) and CISPRI have changed their focus to response cooperatives and now provide manpower and direct spill-response expertise in addition to response equipment. The oil-spill cooperative closest to the proposed sale area is CISPRI. In addition to CISPRI's equipment located at their warehouses in Nikiski, Alaska, CISPRI maintains a dedicated response vessel—the *Banda Seahorse*—and a spill-response barge. Both the *Banda Seahorse* and spill-response barge maintain dedicated oil-spill-response equipment on board. Additional response equipment is available regionally from ACS's equipment cache located in Deadhorse, Alaska, and Alyeska Pipeline Service Company in Valdez, Alaska. It should be noted, however, due to Alaska State law, all the equipment owned by the Alyeska Pipeline Service Company may not be available for response to a spill in areas outside of Prince William Sound. The USCG also maintains a small cache of equipment in Anchorage that may be used in the event of a spill.

(2) **Response Time:** The Guidelines for Approval of OSCP's set a 6- to 12-hour target-response time for initiating recovery operations with prestaged or onsite response equipment if local conditions and geography permit. Response time is defined by the guidelines as the time interval between when the spill occurs and when the response equipment initiates recovery at the spill site. When reviewing OSCP's for possible approval, MMS takes numerous factors into account, such as slick location with proximity to land or sensitive resources and the predicted spill trajectory from the site of operations. The MMS may increase or decrease the required response time depending on the outcome of the analysis. Additionally, while neither the guidelines nor 30 CFR 250.42 contingency-planning regulations require onsite equipment, requirements outlined in the guidelines for onsite oil-spill-response equipment usually are necessary for operators to achieve the response time. Such a requirement, in conjunction with trained spill-response teams at the site of operations, reduces the probability that sensitive areas will be contacted should a spill occur.

(3) **Effectiveness of Oil-Spill Cleanup in the Open Ocean:** There are four accepted approaches for responding to an oil spill in the open ocean—mechanical containment and recovery, chemical dispersant, in situ burn, and the monitor-and-wait response. The monitor-and-wait response may be used during an oil spill because the meteorologic and sea conditions preclude safe response operations, or because the spill does not and is not predicted to persist or cause effects. However, if the monitor-and-wait response is used because of environmental conditions, some of the natural weathering processes may be increased (i.e., dispersion, evaporation, dissolution, and biodegradation). The effectiveness of each, however, depends on timing, weather and sea conditions, available manpower and equipment, as well as a trained response team. Several of the listed factors that affect spilled-oil recovery cannot be changed by spill responders. However, the remaining factors—response timing and the availability of equipment and manpower—may greatly affect the effectiveness of a spill response in the open ocean.

As described in Section IV.A.3, once oil is spilled onto the surface of the water it spreads by gravity, wind, and currents. As the oil spreads, the slick breaks up into smaller, thinner pieces that cover an increasingly larger area. As such, the most effective mechanical response would be conducted during the early hours following a spill, while the slick is still relatively thick and small in aerial extent. Under these conditions, mechanical equipment could spend the majority of time booming and skimming oil rather than chasing individual slicks. Historically, mechanical response has removed 5 to 15 percent (USDOI, MMS, Gulf of Mexico Region, 1983) of the spilled oil from the water surface. For example, during the *Exxon Valdez* oil spill, at-sea recovery of oil was estimated by Exxon at 0.01 percent through the first 2 weeks and 7 percent through the first 3 weeks (Oil Spill Intelligence Report, 1989a,b). The USCG Pollution Reports (USDOT, USCG, 1989a,b) indicate a minimal mechanical-response effort during the first 24 hours of the spill when the slick was thick, small in aerial extent, and conditions were near ideal for a mechanical response. Had a sufficient amount of equipment and personnel been available to respond to this incident during the early hours of the spill before a large amount of spreading had occurred, the initial volume of oil recovered mechanically could have been much higher.

To ensure the most effective mechanical spill response, the lessee normally utilizes onsite equipment as well as a cache of available backup equipment so that the they may take advantage of the early hours following a spill. However, low visibility, high winds, and/or sea states may hamper or halt a mechanical-response effort. As the sea state approaches International Sea State 3 or 4, mechanical equipment loses its effectiveness and mechanical-response operations may be halted. Conversely, increasing sea states (rougher seas) increase the effectiveness of chemical and natural dispersion processes. Because open-water in situ burn operations are conducted with fire-resistant containment boom, they are also limited by the bounds of mechanical response.

While in situ burning may remove a large quantity of oil from the sea surface with high efficiency (greater than 90% in laboratory and tank tests), it is limited by wind speed (approximately 20 kn), the degree of emulsification of the oil (oil will burn if it contains less than approximately 20-30% water), the current and wave constraints for conventional containment boom and, to a lesser extent, time (Allen and Ferek, 1993). In situ burning also may be limited by permit restrictions such as the direction of the wind and the proximity of the potential burn site to populated areas. Such limitations likely would be established during the permit- ting process. The 5- to 15-percent recovery figure referenced above does not include the use of in situ burning. Oil-spill-response capabilities have advanced considerably since the 1983 reference providing for improved detection, containment, recovery, and removal options (USDOI, MMS, Alaska OCS Region, 1991). Recent advances in fireproof containment-boom technology have made the in situ burn response a much more attractive option for spill responders. Such advances in spill-response technology coupled with the increased state of readiness in the sale area and evaporation and natural dispersion could increase the overall oil removal from the water surface to more than 50 percent, provided meteorologic and oceanographic conditions allow a mechanical response. Areas with similar states of readiness and equipment caches to that available in the sale area have experienced such removal during spills. During the *American Trader* spill offshore Huntington Beach, NOAA and the USCG estimate that 69 percent of the spilled oil was removed mechanically, naturally dispersed, and evaporated. In this case a mechanical response was initiated within 12 hours of the spill, and conditions favorable for mechanical response occurred for 6 days (Card and Meehan, 1991). While cases such as the *American Trader* are not common, the nationwide increase in equipment and readiness likely will cause an increase in such successful responses.

(4) Effectiveness of Oil-Spill Cleanup in Broken Ice: Broken ice may be present in the sale area in concentrations greater than 1 octa (4 octas equal approximately 50% coverage) from late November through early April and usually persists in the months of December through March (Brower et al., 1988). Oil spills in such ice conditions may be difficult or impossible to remove mechanically, depending on the concentration of the ice. Generally, there are two methods for cleaning up an oil spill in broken ice, depending on the concentration, mechanical recovery and in situ burning. Mechanical cleanup efforts may be effective in broken ice in concentrations up to approximately 2 octas. In such light ice concentrations, skimming and containment-boom-tow vessels may use avoidance techniques to exclude large pieces of ice, so that mechanical operations may be conducted as they would in open water. Additionally, oleophillic-type mop skimmers may be used to remove contained or uncontained oil from between ice in heavy concentrations and have shown acceptable effectiveness (McGrath and Solsberg, 1990). However, in ice concentrations above approximately 2 octas, mechanical-recovery efforts likely would be relied on less due to the reduced efficiency.

Perhaps the most effective methodology, certainly the most relied-upon methodology in oil-spill-contingency plans submitted to the Alaska Region of the MMS, is in situ burning. Numerous studies have been conducted that demonstrate the viability and effectiveness of the technique for uncontained oil in broken ice, including tank tests conducted by the MMS (Buist, 1987; Brown and Goodman, 1986; Smith and Diaz, 1985). The test results indicate that due to the presence of ice and the water temperature, the oil-spreading rate is reduced, increasing the window of opportunity for in situ burning without introducing mechanical containment equipment. Additionally, the effectiveness of the technique ranged from approximately 65- to 90-percent oil removal, depending on the oil and degree of emulsification (Brown and Goodman, 1986).

(5) Effectiveness of Oil-Spill Cleanup in High Currents and Large Tides: The Sale 149 area is noted for the existence of high currents, extreme tidal range, and rip currents. The existence of high currents can complicate spill-response efforts but does not reduce cleanup efficiencies, provided that the booming and skimming operations are able to move with the current and can avoid rip areas. Stationary response efforts, such as protective booming would, however, be adversely affected. The high currents in Cook Inlet would cause difficulty keeping protective or diversion booms in place throughout the tidal cycle. The rip currents also may cause difficulty with mechanical response and may cause oil within a containment boom to submerge and resurface outside the containment area, as noted in the summary of the tanker *Glacier Bay* spill in Section IV.A.5.a. Because the tides in the area are notably large, a greater extent of the shoreline would receive stranded oil than in shoreline areas where the tides are smaller.

(6) **The Role of the Federal Government During an Oil-Spill Response:** The Federal Government may become involved in an oil-spill response depending on the size and location of the spill. The Federal mandate for Federal involvement is set forth in the National Contingency Plan, 40 CFR 300. The plan sets forth requirements for an Alaskan Regional Response Team (ARRT) comprised of representatives of Federal Government agencies with jurisdiction over the resources at risk. The primary task of the ARRT is to ensure that in the event of an oil or hazardous-material spill, a prudent cleanup effort is launched and spill cleanup is balanced with environmental effects. The policies and procedures that guide the ARRT are set forth in the Alaska Regional Contingency Plan.

In the event of a spill, a FOSC would be appointed based on the location of the spill—for all offshore areas the FOSC is appointed by the USCG. If the spill threatens State resources, a State On-Scene Coordinator would be appointed by the State of Alaska and would be consulted by the FOSC for all decisions that potentially affect State resources. Prior to the Oil Pollution Act of 1990 (OPA 90), it was the FOSC's mandate to ensure that the spill was being removed in the best possible manner. If the FOSC determined that the spiller was not providing an effective response, the FOSC would either require the spiller to commit additional resources or federalize the spill (the Federal Government will take over direction of the response). If the spill were federalized, it became the responsibility of the Federal Government to clean up the spill to the best of its abilities. The OPA 90 changed the FOSC's authority to allow Federal Government spill mitigation prior to any determination of responsibility or the adequacy of the response currently under way. Included in the FOSC's duties is the regulation of chemical and in situ burning use. Such regulation includes bioremediation chemicals, dispersants, herding agents, and a host of other chemical agents listed on the National Contingency Plan (NCP) Product Schedule. According to the NCP, potential approval of the use of chemical agents or burning, where feasible, must be reviewed by the ARRT. While such ARRT approval is prudent, it is time-consuming and may preempt the spiller's use of a chemical or burning response. To avoid such delays, the ARRT created dispersant and in situ burn preapprovals for selected areas within Alaska, one of which includes the Cook Inlet. The preapprovals provide the FOSC with ARRT concurrence for dispersant or in situ burning use, depending on the location of the spill and the time of the year. The ARRT continues to examine these and other areas of preapproval to enhance spill response.

5. **Analysis of Historical Spill Events in the Cook Inlet:** Three oil spills in Cook Inlet are analyzed below in chronological order. The intent of the analysis is to demonstrate a progression in the ability of industry and government to make decisions and clean up an oil spill in the sale area. The three events represent a range of spill sizes in differing environmental conditions and, therefore, serve as examples of responses in conditions present in Cook Inlet.

a. **The Tanker *Glacier Bay* Spill:** The following information has been summarized from the Scientific Support Coordinator's (SSC) Response report (Whitney, 1987, personal comm.). At approximately 3:30 a.m. on July 2, 1987, the tanker vessel *Glacier Bay* ran aground approximately 4 miles (mi) south of Kenai, Alaska, 5 mi out in Cook Inlet. Initial spill estimates indicated that approximately 10 to 20 bbl (420-840 gallons [gal]) of Alaskan North Slope crude oil was released. On July 2, at 6:00 a.m., the USCG reported an additional release of 100 to 400 bbl (420-16,800 gal) occurred when the vessel was moved into deeper waters to facilitate moving the oil from damaged to undamaged tanks on the vessel. The *Glacier Bay* was subsequently moved to Nikiski for offloading. The final spillage estimate, announced 6 days later on July 8, was 3,100 bbl (130,200 gal).

The responsible party assumed responsibility for the spill on July 2 and contracted Cook Inlet Resource Organization (CIRO)—now Cook Inlet Spill Prevention and Response, Inc. At approximately noon on July 2, CIRO requested permission from the FOSC to apply dispersants. As per the dispersant-use guidelines for the Cook Inlet region, the FOSC denied CIRO's request due to the presence of fisheries in the inlet. The CIRO continued to conduct a mechanical response with little effectiveness due to the strong currents, debris, and oil viscosity (Alaskan

North Slope Crude quickly emulsifies with water to become a taffylike substance). On July 9, the FOSC declared the spill major (> 100,000 gal) and assumed control of the spill due to inadequate response and evidence that much more oil had been spilled that initially reported.

Mechanical response operations were difficult primarily due to the currents in the inlet. The oil tended to accumulate in the rip currents, which would submerge the oil. The oil then resurfaced several hundred yards away. It was noted on numerous occasions that oil accumulations in the rip currents were corralled by containment booms and then "disappeared" prior to removal from the water surface. Additionally, the effectiveness of the response was decreased because response personnel did not arrive on scene until 2 days after the spill occurred, allowing the oil to weather, emulsify, and spread.

The effects of the spill were not severe for a major spill. There was little shoreline oiling and four birds were reported killed. The fishery was likely affected the greatest as false slick reporting resulted in unnecessary displacement of fishermen. It is likely that response efforts could have been more effective if they had been in place during the early hours of the spill. Early efforts could have collected more oil while it was fresh, relatively thick and had not had the opportunity to spread. Although the currents in the area hampered the mechanical response, it is thought that the resulting high energy of the Cook Inlet aided the area in a swift recovery.

b. <u>Platform Anna Spill</u>: The following information has been summarized from the USCG Pollution Reports for the Platform Anna spill (USDOT, USCG, 1989b). Sometime during the morning of January 31, 1989, a minor spill occurred from Platform Anna in the Cook Inlet. Initial spill estimates indicated approximately 500 bbl (21,000 gal) of crude oil were spilled from an unknown source on the platform. Those numbers were later reduced to 110 bbl (4,620 gal) of crude oil and 410 bbl (17,220 gal) of oil-contaminated water.

The FOSC and the responsible party conducted an overflight to assess the spill extent during the day of January 31. The oil was sighted approximately 1 mi south of the platform between ice leads in seven patches approximately 15 by 50 feet (ft). Due to severe weather and ice conditions, no cleanup was proposed. An additional overflight was conducted on February 1, and no oil was found. No effects from this spill have been documented.

The example shows that in some instances, the best response to an oil spill, based on size, weather and ice conditions, is no response. The USCG pollution reports indicate that mechanical cleanup would not have been effective, primarily because the weather and ice conditions made the working environment too hazardous to risk the safety of response workers. In situ burning, the only possible effective response in this instance, was not proposed. Unfortunately, the available information is insufficient to determine the feasibility of an in situ burning response.

c. <u>Kenai Pipeline East Forelands Spill</u>: The following information has been summarized from the SSC's Response Report for the Kenai Pipeline East Forelands spill (Whitney, 1992, personal comm.). On January 4, 1992, at approximately 12:30 a.m., a heat tape failed on a pipeline containing oily ballast water at the Kenai Pipeline dock in Nikiski, Alaska. The pipeline subsequently froze and burst, resulting in a 31-bbl (1,302-gal) light-oil spill. Immediately, the facility owners accepted responsibility for the spill and contacted CISPRI to initiate cleanup operations.

Within 45 minutes, CISPRI had initiated mechanical-cleanup operations and had additional equipment at the spill site by daybreak. Cleanup operations lasted approximately 4 days, after which no oil was sighted in Cook Inlet. Additional precautionary measures were taken to protect sensitive resources in the area; however, because the area was never threatened by the spill, the equipment was never deployed. During the day of January 4, CISPRI made an attempt to apply dispersants to the remaining slick. The attempt was unsuccessful; the low temperature caused the dispersant to become too viscous to flow through the application device. No shoreline effects were documented. Following is a summary of the final fate of the oil prepared for the FOSC and responsible party:

- Evaporative and dissolutive losses, 20 to 30 percent
- Sedimentation losses, 1 to 5 percent
- Oil recovered as of 1/7/92, 40 percent
- Oil dispersed across the water surface (over approximately 600 mi^2), 15 to 25 percent
- Oil remaining in rip tides as tarballs, mousse, oiled debris, etc., 5 to 10 percent
- Beached oil, <2 percent

As was expected, the oil's trajectory was similar to that of the *Glacier Bay* spill in that the oil was primarily caught in the rip tides present in the Cook Inlet. Such behavior made the oil's trajectory easy to predict in spite of the near 18 hours of darkness at that time of year. Of the 31 bbl spilled, 16 were skimmed in total, primarily during the first day.

While this spill was not an extremely large spill, the response effort demonstrates a marked improvement over that mounted during the *Glacier Bay* spill. In addition, it shows that the key to an effective mechanical response is maintaining sufficient equipment and personnel in a ready state for a swift response. While it is not likely that an entire slick will be removed once a spill occurs, this response demonstrates that a cleanup effort can be more than marginally effective.

6. <u>Changes in Cook Inlet Spill Response Resulting from the *Exxon Valdez* Spill</u>: Following the grounding of the *Exxon Valdez*, a number of changes came about that significantly affected the state of spill prevention and response in the Cook Inlet. Two significant changes were the passage of the OPA 90 and the revisions made to the CISPRI.

The OPA 90 is comprehensive legislation addressing oil spill prevention and response preparedness for all aspects of the oil industry including exploration, development, and transportation. Executive Order 12777 delegated the OPA 90 responsibilities to the EPA, Department of the Interior, and the Department of Transportation. These Federal Agencies are in various stages of developing final regulations under the OPA 90 to strengthen and expand on oil spill prevention and response planning. The OPA 90 made a number of changes to the regulatory system pertaining to oil and hazardous-material response. The changes raise the planning standard to worst case and require tanker vessels to carry approved response plans based on that standard. The OPA 90 required revision to the NCP and changes the authority of the FOSC in the event of a spill (see Sec. IV.A.3.(c)(6). It further required development of area-contingency plans by local area committees that delineate regions of the country into specific planning areas and outline response strategies specific to that area. It created an effective Regional Citizens Advisory Committee composed of local citizens who are involved in preparing, adopting, and revising response plans as well as overseeing compliance with environmental concerns in the operation of crude-oil terminals.

The *Exxon Valdez* spill in Prince William Sound and spills in the Cook Inlet area have resulted in a number of changes that will further enhance spill response in the sale area. Not only has CISPRI substantially increased its inventory of spill-response equipment, its mandate changed from a resource cooperative that provided only equipment during a spill to a response cooperative that plans for and responds to spills in the Cook Inlet. The CISPRI has recognized the potential of the fleet of fishing vessels available in Cook Inlet to provide assistance during a spill response. The CISPRI has conducted numerous training sessions and drills to prepare such vessels and their crews for a spill event. The CISPRI and Alaska Clean Seas have created a contractual agreement that specifically states terms for sharing personnel and response equipment during a spill response to further reduce response time. The CISPRI and its members also have incorporated the Incident Command System (ICS) into their response strategy. Because the ICS management system is used by many of the possible spillers and response cooperatives in Alaska, response personnel are easily interchanged so that response operations may continue without interruption. Finally, the response community in Alaska continues to improve oil-spill response by conducting and analyzing both industry- and government-sponsored response drills. Overall, the changes to CISPRI should decrease response time, increase the amount of manpower and equipment available and, given weather conditions suitable for a response, increase overall oil removal from the environment.

The *Exxon Valdez* incident demonstrated the deficiencies in the State of Alaska's oil spill regulations. The State has since revised spill-prevention, -response, and response-planning regulations. The regulations are stringent and reflect the spirit of the OPA 90.

The grounding of the *Exxon Valdez* caused the Alaskan spill-response community to review spill response as a whole and look for ways to make improvements to the system. Communication between industry and the Federal, State, and local governments has increased and provides new avenues to plan for large-scale spill responses as a unified team.

7. <u>Major Projects Considered in the Cumulative Case</u>: The analysis for the cumulative case is based on the potential effects associated with (1) exploitation of known or estimated resources from offshore or onshore State and/or Federal oil leases, (2) major potential and ongoing resource-development projects, (3)

Table IV-A.7-1
Major Projects Considered in Cumulative-Effects Assessment
(page 1 of 4)

Project Name	General Location	Resource Estimate(s)	Infrastructure	Annual Production	Status and Comments
State Oil and Gas Lease Sales[1]					
Sale 78	Upper Cook Inlet--Kenai Peninsula and Matanuska Valley	N/A	None	None	Sale 78 offered 608,000 acres for sale in October 1994.
Sale 85	Submerged lands--Cook Inlet and Shelikof Strait	N/A	None	None	Sale 85 offers 700,000 acres for sale in July 1996.
State Oil and Gas Fields[2]					
Ivan River, Lewis River, Pretty Creek, and Stump Lake Units	Located onshore along the north shore of Cook Inlet west of the Susitna River	Gas reserves of 120 Bcf	N/A	16.137 Bcf	Ivan River, Pretty Creek, and Stump River are in production. Produced gas is delivered to the Beluga Power Plant or pumped to Anchorage via the ENSTAR Pipeline.
Beluga River unit	Located along the north coast of Cook Inlet just west of the Beluga River	Gas reserves of 372 Bcf	Site of the Beluga electric power plant	32.28 Bcf	Produced gas is burned for electricity.
North Cook Inlet Unit	Far northern Cook Inlet	Gas reserves of 358 Bcf	Filed served by a single platform	50.22 Bcf	Produced gas is piped to Nikiski for liquefaction and transported to Japan.
Sunfish Discovery	North Cook Inlet Unit	25 MMbbl	Unknown	N/A	Sunfish Discovery wells 1 and 2 were drilled during the fall and winter 1992. ARCO and Phillips announced plans to develop Sunfish in January 1993. Size of filed is approximately 25 MMbbl.
Granite Point Oil Field	Upper Cook Inlet	Oil reserves of 18 MMbbl	Served by three platforms and a production facility	2.242 MMbbl	Produced crude is transported via a 20" pipeline to the Drift River Terminal.
Trading Bay Oil and Gas Field	Trading Bay in Upper Cook Inlet	Oil reserves of 5 MMbbl; gas reserves of 29 Bcf	Served by three platforms	0.751 MMbbl oil, 641 MMcf gas	Trading Bay oil is shipped out through the Drift River Terminal. Gas is pipelined to Anchorage via the ENSTAR system or the Beluga Power Plant.
McArthur River Oil and Gas Field	Trading Bay in Upper Cook Inlet	Oil reserves of 51 MMbbl; gas reserves of 299 Bcf	Served by four platforms	7.06 MMbbl oil, 43.75 Bcf gas	Produced oil in pipelined to Drift River Terminal. Gas is shipped to Anchorage via the ENSTAR system or the Beluga Power Plant.
Middle Ground Shoal Field	Central Upper Cook Inlet off the east Forelands	Oil reserves of 21 MMbbl	Served by four platforms and production facility	2.63 MMbbl oil	Produced oil is pipelined to Nikiski.
Swanson River Unit	Kenai Peninsula	Oil reserves of 13 MMbbl; gas reserves of 43 Bcf	served by eight production wells	1.673 MMbbl oil; gas reinjected to preserve oil production	Produced oil is pipelined to Nikiski for processing at the Tesoro Refinery.
Beaver Creek Unit	Kenai Peninsula	Oil reserves of <1 MMbbl; gas reserves of 128 Bcf	Served by three production wells	0.143 MMbbl oil; 1.40 Bcf gas	The field's oil potential is 83 percent depleted. Produced crude is transported to Nikiski via tanker truck for processing and transshipment. Gas is pipelined to the Nikiski petrochemical complex.

Table IV-A.7-1
Major Projects Considered in Cumulative-Effects Assessment
(page 2 of 4)

Project Name	General Location	Resource Estimate(s)	Infrastructure	Annual Production	Status and Comments
Kenai Gas Field	Coastal Kenai Peninsula south of Kenai.	Gas reserves of 191 Bcf	Served by 47 production wells	18.5 Bcf gas	The field's production has a variety of end users.
Oil and Gas Transportation					
Phillips-Marathon LNG Plant	Community of Nikiski on the Kenai Peninsula	N/A	Two liquefaction trains. Approximate capacity--200 MMcf/day.	Liquefies 1 million tons of natural gas annually	Natural gas is received from the North Cook Inlet and other fields. LNG is shipped to Japan 32 times a year. In the summer 1993, Marathon put into service two new 80,000-m³ tankers[3].
Drift River Oil Terminal[4]	West shore of Cook Inlet across from Kalgin Island	N/A	Storage tanks and offshore loading	Loads and stores at least 9 MMbbl annually	99 percent of Drift river crude oil is transported to Olium,CA; 29 tanker trips/year issue from the terminal with an avenge cargo of 293,200 bbl.
Alaska North Slope Crude[5]				25-28 MMbbl moved to the Tesoro Nikiski Refinery annually	North Slope crude has been shipped via tanker to Nikiski since 1986.
Import Tankering[6]	N/A	N/A	N/A	1992--323,000 bbl imported from Australia	Foreign crude oil is intermittently imported to the Tesoro refinery, usually one shipment per year.
Noncrude Carrier[7]	N/A	1,000 million gallons annually transit Cook Inlet	N/A	N/A	In 1991, at least 45 tank vessels and tank barges with an average capacity of 12 million gallons transited the Cook Inlet. Cargos included; gasoline, diesel, #6 fuel oil, naphtha, Jet-A, avgas, and solvents.
Mineral Industry					
Coal Export Development[8]	Matanuska Valley and Interior Alaska	Proven reserves, 707 million metric tons	Coal port location uncertain.	10, million metric tons exported annually by the year 2000	A port exporting coal mined in Interior Alaska is expected to be constructed in either Anchorage or in the Matanuska-Susitna Borough in this decade. The project may use 42,000 dead-weight-ton coal carriers. If so 200-250 vessels trips per year could be expected.
Johnson River Mineral Development[14]	Lake Clark National Park	Undefined	Iliamna Point near the mouth of Johnson Rive	270,000 tons per year over 3 years	Metalliferous ore mine. Two 15,000-ton barges per month for 3 years.

Table IV-A.7-1
Major Projects Considered in Cumulative-Effects Assessment
(page 3 of 4)

Project Name	General Location	Resource Estimate(s)	Infrastructure	Annual Production	Status and Comments
Timber Industry (Spruce Bud Worm Infestation Harvest)					
Chugach National Forest	Eastern Kenai Peninsula, Prince William Sound	N/A	N/A	Harvested 3 million board feet in 1993	The Chugach National Forest's Plan in 1993 proposed the harvest of 3 million board feet of infested timber and about 2 million board feet in subsequent years.
Ninilchik Area	Mid-Kenai Peninsula	N/A	Seward sawmill	Harvest of 54 million board feet per year for 10 years	The Chugach Alaska Corporation controls an estimated 1 billion board feet of timber and has invested more than $20 million in setting up a sawmill in Seward. Besides Ninilchik, infested timber is scheduled to be harvested in Windy Bay and Fish Bay areas.
Windy Bay	Southwestern. edge of Kenai Peninsula	N/A	N/A	Harvest of 18 to 100 million board feet per year	See above.
Fish Bay	East side of Prince William Sound	N/A	N/A	Harvest of 10 to 125 million board feet per year	See above.
Public Facilities					
Kodiak Harbor[10]	Kodiak	N/A	N/A	N/A	A rubblemound breakwater is being built for the harbor along with construction that will increase harbor-moorage capacity by 80 slips. These projects were instituted to meet the needs of the fishing industry and should be completed by 1996.
Anchor Point[11] Harbor[11]	Kenai Peninsula	N/A	No existing boat Harbor.	N/A	An $11.3 million small-boat harbor and dredging project is under consideration by the Corps of Engineers and the State.
Port of Anchorage	Municipality of Anchorage	N/A	Multiple-use dock facilities, extensive service and support capabilities	N/A	For the fourth year in a row, vessel dockings have increased. In 1992, 541 vessels docked--319 were cargo vessels, 214 were deepwater freighters, 15 were petroleum tankers, and 92 were barges (76 were oil carriers). No cruise ship ships docked--down from 4 in 1991. Cargo volumes and vessel traffic may decline.

Table IV-A.7-1
Major Projects Considered in Cumulative-Effects Assessment
(page 4 of 4)

Project Name	General Location	Resource Estimate(s)	Infrastructure	Annual Production	Status and Comments
Past OCS Oil and Gas Lease Sales					
Sale CI	Lower Cook Inlet	No commercial discoveries	NA	NA	87 tracts leassed in October 1977. 10 wells drilled between 12/78 and 06/80. All wells have been plugged and abandoned and all leases relinquished
Sale 60	Lower Cook Inlet and Shelikof Strait	No commercial discoveries	NA	NA	13 tracts leased in September 1981. 3 wells drilll between 11/84 and 04/85. All wells have been plugged and abandoned and all leases relinquished
RS-2	Lower Cook Inlet and Shelikof Strait	No commercial discoveries	NA	NA	No tracts were leased in the 1982 re-offering sale.

Source: USDOI, MMS, Alaska OCS Region, 1993.

[1] State of Alaska, DNR, Div. of Oil and Gas, 1993.
[2] State of Alaska, DNR, Div. of Oil and Gas, 1995.
[3] Timlin, personal comm., 1992.
[4] Duncanson, personal comm., 1992.
[5] USDOT, Maritime Administration, 1991.
[6] Gduala, personal comm., 1992.
[7] Arthur D. Little, Inc., 1991.
[8] Peratovich, Nottingham, and Drage, Inc., and The McDowell Group, 1993.
[9] Wiedmer, personal comm., 1993; AEIDC, 1991; Cuccarese et al., 1987; USDOI, MMS, Alaska OCS Region, 1986.
[10] McCorkle, personal comm., 1993.
[11] Beckley, personal comm., 1993..
[12] Port of Anchorage, Port Facilities, 1992; Port of Anchorage, 1992; 1988-92.
[13] USDOD, Army Corps of Engineers, 1992.
[14] Cook Inlet Region Inc.. and Westmin Resources Ltd., 1994.

major potential and ongoing construction projects, and (4) other facilities whose activities may affect the proposed sale area. Information on the past, present, and future projects considered in the cumulative-case analysis is summarized in Table IV.A.7-1.

The OSRA model estimates a mean number of 2.00 spills ≥ 1,000 bbl are likely to occur as a result of the cumulative-case scenario, with an estimated 86-percent chance of one or more such spills occurring. For the purposes of analysis, this EIS assumes two 50,000-bbl spills will occur for a total spill volume of 100,000 bbl.

8. Mitigating Measures: The mitigating measures noted in Section II.H.1 are considered part of the proposal and, thus, factored into the environmental effects analyses. Through increasing awareness and preparedness, these measures help reduce the environmental effects the proposal might have on the cultural, archaeological, and biological resources in and adjacent to the sale area. For Alternative I (base case), a separate summary analysis of effects is presented, after the conclusion, where the analysis indicates there may be significant differences between effects levels as analyzed with the mitigating measures in place and no measures appropriate to that resource.

B. Effects Assessment:

1. Alternative I, The Proposal, Base Case:

Description of the Proposal: Alternative I (the proposed action) would offer for lease those parts of the Cook Inlet Planning Area identified in Figure II.A.1. The Alternative I area consists of approximately 403 whole and partial blocks encompassing approximately 1.9 million acres. The area of the proposed action is located between about 3 and 25 miles (mi) offshore in water depths that range from 1 foot (ft) to approximately 650 ft.

In addition to Alternative I, six other alternatives are being recommended for consideration in the Sale 149 EIS (see this section).

The proposed action and the alternatives will be analyzed on the basis of a field development time profile called a scenario. The MMS traditionally bases the EIS scenarios on geologic possibilities and what is expected to be leased, discovered, developed, and produced in the sale under consideration. The location of any oil deposits is purely hypothetical until oil is proven to be there by drilling (Appendix A). Where these geologic possibilities are located plays a strong factor in the proposed scenario, and the scenario forms the basis for the analysis of what effects are anticipated.

Activities Associated with the Proposal, Base-Case Activities:

(1) Resource Estimates and Basic Exploration, Development and Production, and Transportation Assumptions for Effects Assessment:

(a) Assumed Base-Case Resources: The base case assumes 200 million barrels (MMbbl) of oil may be found within the boundaries of this alternative. Table IV.A.1-1 displays the levels of infrastructure and resources that were assumed for the analysis of the effects of the Proposed Action in Section IV. Although the development of natural gas resources is not considered economic for this proposed sale, the effects of any theoretical natural gas discovery are discussed in Section IV.F.

(b) Timing of Activities: The level of activities and the timing of events associated with the base case for Alternative I are shown in Table II.A.1. Exploratory drilling is expected to begin in 1997 and continue through 1998. A total of eight exploration and delineation wells are assumed would be drilled between 1997 and 1998. Installation of three production platforms is expected to occur in between 1999 and 2001, and pipeline laying is expected to begin and conclude in the year 2002. Drilling of production and service wells is expected to begin in 2000 and continue through 2002, with a total of 48 wells drilled. Production is expected to begin in 2003 and continue through 2021. These calculations are based on an average drilling season, which potentially could be year-round in the lower Cook Inlet; however, unusually heavy winter ice, storms, and various environmental regulations could affect this hypothetical drilling schedule.

(2) Activities Associated with Exploration Drilling:

(a) Seismic Activity: In support of the proposed exploration and production activities, the lessee/operator is required to conduct surveys of sufficient detail to define shallow hazards or the absence thereof; these surveys should incorporate seismic profiling. The projected level of seismic activity is based on the nature and extent of the surveys that may be required (NTL 89-2, Minimum Requirements, Shallow Hazards Survey) and the predicted number of wells drilled. Surveys of the exploration- and delineation-well sites would be conducted during the ice-free seasons of the years of the exploratory phase. For this EIS, it is assumed that each of the eight exploration wells would be covered by site-specific surveys. These surveys would cover an approximate area of 8.9 mi^2 of data for each well; the total area covered by seismic surveys could equal 71.2 mi^2. These surveys usually are conducted 1 year prior to drilling. Surveys would be done during ice-free periods (March through October). The average time needed to survey each site should range between 2 and 5 days, allowing for downtime for bad weather and equipment failure. It should be noted that NTL 89-2 allows some flexibility for waiving the seismic requirement if sufficient data are available that can "determine the presence or absence of sea floor and subsurface geological and man made hazards."

(b) **Exploration Drilling:** Water depth will be a significant factor in selecting the appropriate drilling unit. In the lower Cook Inlet, most depths within the sale area can be found between 250 and 300 ft. Exploratory drilling throughout much of this area would be carried out by semisubmersible drilling units; however, in shallower waters, <300 ft, jack-up rigs could be used. Semisubmersible drilling units can operate in the strait throughout the year. In the shallower portions of the Cook Inlet, larger jack-up rigs could remain onsite throughout the winter or spend the season in an ice-free port such as Kachemak Bay. Farther south in the Cook Inlet, the waters are ice-free throughout the year. Semisubmersible drilling units can operate in these ice-free waters throughout the year. Exploration-well-drilling depths should average 6,000 ft.

Drilling of each exploratory or delineation well would require the disposal of about 360 short tons of drilling muds and produce approximately 440 short tons of drill cuttings. These are dry-weight figures. The total amount of muds and cuttings estimated to be disposed of for all exploration and delineation wells is expected to be 2,880 short tons of drilling muds. The total amount of bore cuttings produced is expected to reach 3,520 short tons. Again, these are dry-weight figures. These materials will be disposed of primarily at the drill site under conditions prescribed by EPA's NPDES (Rathbun, 1986; Clean Water Act of 1977, as amended [33 USC 1251 et seq]).

(c) **Support and Logistics Activities:** The following assumptions for supporting exploration activities are speculative. They are a reflection of what was required to support offshore activities in previous exploratory drilling efforts in the lower Cook Inlet. Marine support for exploration in the Cook Inlet primarily would be staged from the Rig Tenders Dock in Nikiski. Logistics support would be aided by the network of oil-field-service contractors in the Kenai/Nikiski area. During the exploratory period, support/supply vessels can be expected to visit the drill platform every 1 to 2 days (or as needed). Any tugs required to assist the drilling unit in moving to other prospects or for emergency purposes would remain on station near the drilling unit.

Air support for offshore drilling in the lower Cook Inlet is expected to come from the Kenai/Nikiski area, probably from the municipal airport; air support also might come from a helipad operated by an oil-field contractor. Offshore workers, mail, drill cores, and various perishable and lightweight priority items would be transported to the site by helicopter. There should be at least one helicopter assigned for each drilling unit and one held in reserve for emergency purposes. Helicopter trips per day per platform will vary, with the average between one and two a day.

Drilling-unit crews primarily would be workers from outside the lands adjacent to the sale area. However, given the Kenai Peninsula's history of involvement with oil and gas development, some exploration workers well may be residents of the Kenai Peninsula. In general, workers would travel to and from the sale area by jet or turboprop aircraft and would use the airport at Kenai. These crews would be transferred to site by helicopter.

(3) **Activities Associated with Development and Production:** Assumptions associated with development and production strategies are highly speculative. Because of this, the scenario described here is meant to be characteristic of the type of development that could accompany production. Under this scenario, work on offshore and onshore production and transportation facilities would not begin until the engineering and economic assessments of the potential reservoirs had been completed and the conditions of all the permits had been evaluated. As shown in Table II.A.1, the first delineation well is projected to be drilled in 1997, with production beginning by at least 2003. Production is assumed to peak approximately between 2004 and 2008 and cease in 2021.

(a) **Seismic Activity:** A three-dimensional, multichannel, seismic-reflection survey would be conducted for the production platforms. The survey would cover approximately 106.5 mi^2. The platform sites may be surveyed several years prior to the installation of the platform; surveys would be conducted during open-water, ice-free periods. High-resolution seismic-reflection data for shallow hazards would be collected prior to laying the offshore pipeline. The total trackline distance, estimated to be four times the length of the trunk pipeline assumed for the scenario, would equal approximately 500 statute miles.

(b) **Production Drilling:** Assuming commercial discoveries within the sale area, the production platform type that most likely would be used is a steel-jacket bottom-founded drilling platform, engineered for ice resistance, similar to those already in place in the upper Cook Inlet. Construction and outfitting of the platform would occur in an ice-free harbor of the North Pacific. After staging, the platform would be towed and installed during an ice-free period. Drilling of development wells could begin while the platform was only partially installed and while production facilities were being readied for operation. Target depth for production wells is estimated at 7,500 ft.

A total of 48 production and service wells is estimated would be drilled from three production platforms from 2000 through 2002. Drilling of the production and service wells would require 80 to 370 short tons of drilling mud per well (dry weight). Some of the muds used in drilling production and service wells may be recycled through each subsequent well drilled on the platform. Depending on the amount recycled, the amount of drilling muds disposed of could range from 3,840 to 17,760 short tons of drill muds (dry weight) for all wells drilled. Each well also is expected to produce approximately 560 short tons of rock cuttings (dry weight), with the total amount of cuttings disposed of amounting to about 26,880 short tons (dry weight). The disposal of muds and cuttings would be in accordance with approved USEPA NPDES permits for development well drilling; muds and cuttings also would be transported to shore and disposed of at approved sites.

(c) **Support and Logistics Activities:** Air- and marine-support activities are expected to be staged from the Kenai Peninsula. Support-vessel operations would be staged from the Rig Tenders Dock at Nikiski. Material storage and general logistics support would be facilitated by Kenai's existing oil-field-support infrastructure. This infrastructure, a network of private contractors, has developed over the last 20 years to serve onshore oil and gas production on the Kenai Peninsula and offshore production in the upper Cook Inlet. Air support for lower Cook Inlet drilling operations also would come from the Kenai/Nikiski area. A dedicated helipad at the Kenai airport could be used to transfer personnel to the drill site. Personnel arriving for transport to the drill site are expected initially to enter the Kenai area via commercial fixed-wing aircraft; however, early on in the developmental phase offshore workers are expected, for the most part, to be or become local residents.

Support-boat operations are expected to average between one and two a day per platform (or as needed), the frequency diminishing into the production period. Air operations may reach two a day per platform as an average and decline into the production phase. Additional support vessels and helicopters would be kept on contract in proximity to drill operations to provide emergency assistance, if required.

(4) **Activities Associated with Oil Transportation:** Should recoverable quantities of hydrocarbons be located, construction of expanded oil and gas processing facilities and tanker docks could begin in the Nikiski area 3 years after the sale date; trunk-pipeline laying would begin and conclude 6 years after the sale date. Production is assumed to begin 7 years after the sale. In the case of lower Cook Inlet, produced crude would be transported via a 12-inch diameter, 125-mi long, subsea pipeline to the Nikiski petroleum complex. The subsea pipeline would not be buried; because of the turbid conditions of the Cook Inlet and the depth at which the pipeline would rest, the weighted pipe would become covered with silt or would be self-buried. The exception to the aforementioned statement, arises in the two to three mile portion of the pipeline that approaches the tidelands. In this area, the pipeline will be buried to prevent damage from natural or human causes.

Support-boat operations are expected to average between one and two a day per platform (or as needed), the frequency diminishing into the production period. Air operations may reach two a day per platform as an average and decline into the production phase. Additional support vessels and helicopters will be kept on contract in proximity to drill operations to provide emergency assistance, if required.

At the Nikiski complex, if necessary, existing oil-storage facilities would be expanded to accommodate the additional crude production. An additional tank farm of <30 acres would be created on lands adjacent to the Nikiski petroleum complex. Should all the crude oil produced by the proposed action be tankered from Nikiski to the west coast of the U.S., tankerage may average 45 to 50 per year presupposing the use of 45,000-DWT tankers. However, it is assumed in Section IV.a.2.b (the discussion of the assumptions of the Oil Spill Risk Analysis [OSRA]) that 66 percent of the oil produced by the base case would be shipped out of State and 34 percent of produced crude would be processed in State. This percentage corresponds to the current transportation distribution of crude oil produced from State of Alaska leases. Crude oil transported from Nikiski may be refined in the Puget Sound, the San Francisco-Oakland Bay area, or the vicinity of the Port of Los Angeles. Figure IV.B.1-1 indicates the approximate routes of oil tankers to the west coast. Except when entering port, tanker routes usually are 100-200 mi offshore, although some industry sources indicate that the crude carriers may come within 80 mi of shore.

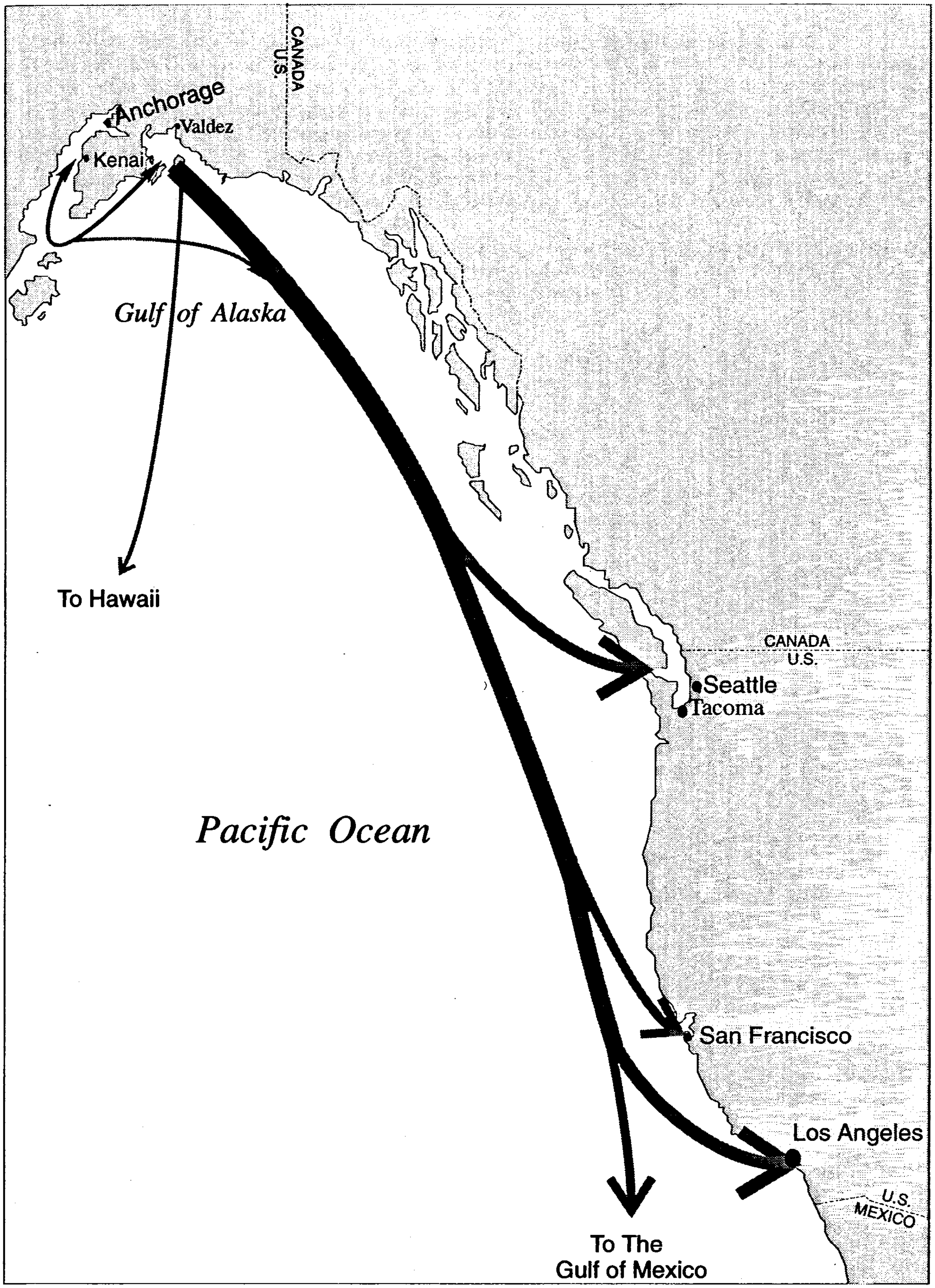


Figure IV.B.1-1. General Tanker Routes and Ports of Entry

a. **Effects on Water Quality**: For Alternative I (base case), the activities associated with petroleum exploitation most likely to affect water quality in the Cook Inlet/Shelikof Strait (CI/SS) sale area are (1) the permitted discharges from exploration-drilling units and production platforms, (2) accidental oil spills, and (3) construction activities. The meteorological and oceanographic factors affecting the marine waters of CI/SS are described in Sections III.A.2 and 3; the characteristics of the waters are described in Sections III.A.4 and 5. The permitted discharges and offshore construction activities and any accidentally spilled oil would add substances that may be (1) foreign to or (2) increase the concentration of constituents already present in the water column of CI/SS. As noted in Section III.5.e, the quality of lower Cook Inlet water generally is good (unpolluted).

The principal method for controlling pollutant discharges is through Section 402 (33 U.S.C. § 1342) of the Federal Water Pollution Control Act (commonly referred to as the Clean Water Act) of 1972, which establishes an NPDES (Laws, 1987); see Section III.5.d(1). The types of pollutants regulated by the USEPA are shown in Table IV.B.1.a-1.

(1) **Permitted Discharges:** The permitted discharges associated with the base case petroleum-industry discharges in CI/SS would come from exploration and development and production operations. Drilling muds and cuttings and produced waters are the most significant discharges associated with offshore operations and have received the most attention; the analysis in this section primarily focuses on these two discharges.

Estimates are presented in this section on the amount of muds and cuttings and produced waters that might be discharged from Sale 149 exploration-drilling units and an oil-production platform; these estimates are based on discharge rates that are assumed to be characteristic of "present-day" drilling and oil-production operations in upper Cook Inlet, which began in the late 1960's. Future procedures and technologies for treating and handling the discharges could be modified to reduce, and perhaps eliminate, the discharge of muds and cuttings and produced waters into CI/SS (Short, 1993).

(a) **Exploration:** During the exploration phase of the base case, (1) three exploration wells would be drilled—two in 1997 and one in 1998 and (2) five delineation wells—two in 1997 and three in 1998 (Tables IV.A.1 and 2). The base case assumes there would only be one drilling unit used each year to drill these wells; thus, only one well will be drilled at a time. Drilling muds and cuttings are the most significant discharge during exploration drilling; other discharges are briefly mentioned in this section. The amount of time required to drill each exploration and delineation well is estimated to be between 2 and 3 months.

1) **Drilling Muds and Cuttings:** Drilling muds are mixtures of water and natural and manmade additives that are pumped downhole to (1) cool the rapidly rotating drill bit, (2) lubricate the drill pipe as it turns, (3) carry rock cuttings to the surface, and (4) provide weight or hydrostatic head to prevent formation fluids from entering the well bore and control downhole pressures. The principal bulk constituents of drilling muds are water, barite, clay minerals, lignosulfonate, lignite, and sodium hydroxide (NRC, 1983); water constitutes about 75 to 85 percent of the volume of most drilling muds currently used in Cook Inlet (Neff, 1991). In the drilling muds, the amount of barite might range from 0 to 450 pounds (lb)/bbl, clay from 10 to 50 lb/bbl, and other constituents from 0 to 50 lb/bbl (NRC, 1983). These constituents generally are nontoxic to marine organisms at the dilutions reached shortly after discharge (NRC, 1983). The discharge of drilling muds and cuttings likely would constitute the largest volume of discharges, other than seawater, during the exploration drilling.

Turbidity Water-Quality Criteria: The USEPA and State of Alaska criteria related to increasing the turbidity in the water column are quite similar. The USEPA (1986) criteria for solids suspended and turbidity for freshwater fish and other aquatic life states: Settable and suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10 percent from the seasonally established norm for aquatic life.

The State of Alaska (1989) water-quality criteria for turbidity (marine-water uses for growth and propagation of fish, shellfish, aquatic life, and wildlife) states: ". . .shall not reduce the depth of the compensation point for photosynthetic activity by more than 10%. In addition, . . .shall not reduce the maximum secchi disk depth by more than 10%."

Table IV.B.1.a-1
Types of Regulated Pollutants

CONVENTIONAL POLLUTANTS: Conventional pollutants are contained in the sanitary wastes of households, commercial establishments, and industries. These wastes include human wastes, sand, leaves, trash, ground-up food from sink disposals, and laundry and bath wastes. Five specific pollutants are considered " conventional pollutants":

> **Biochemical Oxygen Demand** (BOD): This parameter measures the quantity of oxygen used in aerobic oxidation of the organic matter in a sample of wastewater.
>
> **Total Suspended Solids** (TSS): This parameter is a measure of the concentration of solid particles suspended in wastewater.
>
> **Fecal Coliform**: The bacteriological quality of water is based on testing for nonpathogenic indicator organisms, principally the coliform group. Fecal coliform bacteria are used as a measure of health risk, because they are more easily detected and pathogens. Fecal coliform bacteria are found in the digestive tracts of humans and animals. Their presence in water indicates the potential presence of pathogenic organisms.
>
> **pH**: pH is a measure of acidity or alkalinity. pH is measured on a scale of 1 to 14; 1 being extremely acidic, 7 neutral, and 14 extremely alkaline. Most healthy surface waters have nearly neutral pH; i.e., they are neither strongly acidic nor alkaline.
>
> **Oil and Grease**: This parameter is a measure of the concentration of a variety of organic substances including hydrocarbons, fats, oils, waxes, and high-molecular fatty acids. These pollutants degrade receiving-water quality when present in excessive amounts. They also are a concern to municipal and industrial waste treatment, because they reduce the biological treatability of the waste and produce sludge solids that are difficult to process.

TOXIC POLLUTANTS: Toxic pollutants represent a list of 126 pollutants that are particularly harmful to one or more forms of animal or plant life. They are primarily grouped into organics and metals.

> **Organic Pollutants**: These pollutants include pesticides, solvents, polychlorinated biphenols (PCB's), and dioxins.
>
> **Metals**: The metals of concern include lead, silver, mercury, copper, chromium, zinc, nickel, and cadmium.

NONCONVENTIONAL POLLUTANTS: Nonconventional pollutants are any additional substances that are not in the grouping "conventional" or "toxic" that may require regulation. These include nutrients such as nitrogen and phosphorus.

Source: USEPA, 1990.

A mixing zone, as defined by the State of Alaska (1989), "...means the area adjacent to a discharge or activity in the water where a receiving water may not meet all the water quality standards; wastes and water are given an area to mix so that the water quality standards are met at the mixing zone boundaries." The size of each mixing zone must comply with the following limitations: "...The cumulative linear length of all mixing zones intersected on any given cross section of an estuary, inlet, cove, channel, or other marine water measured at mean lower low water may not exceed 10 percent of the total length of that cross section, nor may the total horizontal area allocated to mixing zones in these waters exceed 10 percent of the surface area measured at mean lower low water."

Section 403(c) of the Federal Water Pollution Control Act (Clean Water Act) regulations allow a 100-m radius mixing zone for initial dilution of discharges (Appendix J). The mixing zone means a limited area or volume of water where initial dilution of a discharge takes place and where numeric water quality can be exceeded, but acutely toxic conditions are prevented from occurring (40 CFR 131.35).

The suspended particulate matter (SPM) concentrations noted in this section are reported in milligrams per liter (mg/l) and cannot be directly correlated with the USEPA and State criteria. Abernathy, Gilliam, and Klouda (1989) notes SPM concentrations in the 100 to 1,000 ppm (≈ 100-1,000 mg/l) range are known to have sublethal effects on marine biota. Thus, for this analysis the chronic criteria for SPM/turbidity is assumed to range from 100 to 1,000 mg/l. Also, the particulate concentration in the drilling muds and cuttings at the time of discharge and after an initial mixing can be compared to background SPM concentrations in the CI/SS water column, and this may be a more useful means of evaluating the effects of these discharges.

Sale 149 Exploration-Drilling Discharges: The drilling of each exploration or delineation well is expected to result in the discharge of an estimated 360 tons (dry weight) of mud and 440 tons (dry weight) of cuttings (Table III.A.5-15). The total dry-weight discharge for drilling the eight exploration and delineation wells is estimated to be 2,880 tons of drilling-mud components and 3,520 tons of cuttings during a 3-year period (Table IV.B.1.a-2). This amount of material is a fraction of the particulate matter rivers discharge daily into Cook Inlet. The May to October mean discharge rates and suspended sediment loads for the major rivers discharging into Cook Inlet are shown in Table III.A.5-1.

Bulk discharges of drilling muds, usually about 100 to 200 bbl at a time, may occur several times during the drilling of a well, when the composition of the drilling mud has to be changed substantially or when the volume exceeds the capacity of the mud tanks. Washed drill cuttings and a small volume of drilling-mud solids are continuously discharged during drilling operations; the discharge rate varies from about 4 to 40 cubic meters per day (m^3/day) (about 25-250 bbl)—the high amount is more characteristic of the discharges early in the drilling program (Menzie, 1982). When the drilling and testing of an exploratory well are complete, there may be a bulk discharge of between 1,000 and 2,400 bbl of drilling mud. As noted in Appendix J, the Cook Inlet/Gulf of Alaska general NPDES permit states that: "...the total drilling muds, drill cuttings, and washwater discharge rate shall not exceed:

(a) 1,000 bbl/hour in water depth exceeding 40 m,
(b) 750 bbl/hour in water depth greater than 20 m to 40 m, and
(c) 500 bbl/hour in water depths 5 to 20 m."

Drilling muds and cuttings discharged into Cook Inlet would increase the turbidity of the water column and the rate of accumulation of particulate matter on the seafloor in the vicinity of the drilling unit. The discharge of drilling muds at the surface ensures dispersion and limits the duration and amount of exposure to organisms (NRC, 1983). When released into the water column, the drilling muds and cuttings discharges tend to separate into upper and lower plumes (Menzie, 1982). The upper plume contains the solids separated from the material of the lower plume and kept in suspension by turbulence. Most of the solids in the discharge, >90 percent, descend rapidly (<1 hour) to the seafloor in the lower plume. The heaviest materials (e.g., barite particles and cuttings) accumulate closest to the discharge point and the lighter mud components settle farther away. Small particles of drilling mud—several centimeters in diameter—also may settle to the seafloor immediately following a discharge but would disperse within a day (NRC, 1983).

The fate of the drilling muds and cuttings discharged into Cook Inlet may be indicated by the continental offshore stratigraphic test (COST) well drilled in the summer of 1977 in lower Cook Inlet at a site between Kachemak and Kamishak Bays (Dames and Moore, 1978) in waters about 50 m deep. Dye studies and modeling of the discharge

Table IV.B.1.a-2
Exploration and Development and Production Well and Discharage Data

					Drilling Muds and Cuttings					Produced Waters					Drilling Muds		
					Exploration and Delineation[1] (Tons)		Development and Production[2] (Tons)										
Alternatives	Exploration Wells	Delineation Wells	Production Platforms	Production & Service Wells	Muds	Cuttings	Muds	Cuttings	Assumed Oil Production (MMbbl)	Produced Waters[3] (MMbbl)	Oil and Grease[4] (Tons)	TAH[5] (Tons)	BOD[6] (Tons)	Zinc[7] (Tons)	Barium[8] (Tons)	Mercury[9] (lb)	Cadmium[10] (lb)
I Base Case	3	5	3	48	2,880	3,520	3,840-17,760	26,880	200	18-148	60-933	25-337	1,303-13,434	0.1-11	2,498-7,762	9-26	25-78
IV Wildlife Concentration	3	4	3	41	2,520	3,080	3,280-15,170	22,960	160	14.4-118.4	48-747	20-270	1,042-10,747	0.08-9	2,156-6,575	7-22	22-67
V Coastal Fisheries	2	3	2	29	1,800	2,200	2,320-10,730	16,240	140	12.6-103.6	42-654	18-236	912-9,404	0.07-8	1,531-4,657	5-16	16-47
VI Pollock-Spawning Area	3	4	3	40	2,520	3,080	3,200-14,800	22,400	150	13.5-111.0	45-700	19-253	977-10,075	0.07-8	2,126-6,438	7-22	22-65
VII General Fisheries	2	-	-	-	720	880	-	-	(40)[11]	-	-	-	-	-	268	<1	3
VIII Northern	2	3	2	29	1,800	2,200	2,320-10,730	16,240	140	12.6-103.6	42-654	18-236	912-9,404	0.07-8	1,531-4,657	5-16	16-47
IX Kennedy Entrance	3	5	3	48	2,880	3,520	3,840-17,760	26,880	200	18-148	60-933	25-337	1,303-13,434	0.1-11	2,498-7,762	9-26	25-78
I Low Case	3	-	-	-	1,080	1,320	-	-	-	-	-	-	-	-	401	1	4
I High Case	11	17	11	198	10,080	12,320	15,840-73,260	110,880	800	72-592	240-3,734	101-1,349	5,211-53,736	0.38-44	9,634-30,977	33-105	98-315

[1] Amounts are based on each exploration and delineation well using 360 tons (dry weight) of drilling muds and producing 440 tons (dry weight) of cuttings.

[2] Amounts are based on each production or service well using between 80 and 370 tons (dry weight) of drilling muds and producing 560 tons (dry weight) of cuttings.

[3] The amounts of produced waters are based on a ration of 0.09 to 0.74 bbl of oil being produced for each bbl of oil.

[4] The amounts of oil and grease (nonvolatile hydrocarbons) are based on the concentration of oil and grease in the produced waters ranging from 19 to 36 mg/l.

[5] The amounts of total aromatic hydrocarbons (TAH) in the produced waters are based on TAH concentrations of 8 to 13 mg/l.

[6] The amounts of biological oxygen demand (BOD) in the produced waters are based on BOD concentrations of 413 to 518 mg/l.

[7] The amounts of zinc in the produced waters are based on concentrations of 0.03 to 0.42 mg/l..

[8] Drilling muds are composed of about 37 percent by dry weight of barium.

[9] The amounts of mercury in the drilling muds are based on concentrations of 1 mg of mercury per 1 kg of barite.

[10] The amounts of cadmium in the drilling muds are based on concentrations of 3 mg cadmium per 1 kg of barite.

[11] No production is assumed for this resource estimate.

plume, conducted in conjunction with the drilling of the COST well, indicated rapid dilution to a minimum value of 10,000:1 within 100 m (0.03 km^2) of the drilling vessel. Following dilution, the increase in turbidity caused by the discharge of drilling muds was calculated to be about 8 mg/l; background turbidity in the area ranged from 2 to 20 mg/l.

In waters deeper than 40 m modeling, using discharge rates of 500, 750, and 1,000 bbl/hour and current speeds of 2 to 150 centimeters per second (cm/s) (about 0.04-3 kn), estimates minimum solids-dilution rates might range from about 1,000:1 to 6,000:1 at 100 m; in general, dilution rates increased with increasing current speed and water depth and decreasing discharge rate (Appendix J). Modeling also estimated the minimum dilution rates for dissolved substances to range from about 1,000:1 to 27,000:1.

The dynamic nature of the bottom-current regime at and near the COST well site appeared to have washed most of the mud from the cuttings and limited the accumulation of cuttings and mud (including some barite particles) to a rate that did not appear to significantly affect benthic populations. During the drilling of the COST well, cuttings and barite particles that reached the seafloor were rapidly dispersed by strong tidal currents; the maximum velocity of the currents was 99 cm/s (about 2 kn).

Dilution rates as high as 1,000,000:1 may occur for drilling solids within a distance to 200 m (0.13 km^2) of a platform with surface currents of 30 to 35 cm/s (about 0.6-0.7 kn) (NRC, 1983). As noted in Section III.A.3.a(2), tidal currents in lower Cook Inlet may have velocities of 102 to 153 cm/sec (about 2-3 kn), or more. The currents associated with the Cook Inlet circulation regime, especially the strong tidal currents, and the geometry of the inlet produce considerable cross currents and turbulence in the water column during both ebb and flood tides; Sections III.A.2, 3, and 4. The cumulative effects of hydrodynamic processes suggest the water column in lower Cook Inlet generally is vertically well mixed. The similarities between the respective SPM concentrations, salinities, and temperatures at the surface and near the bottom not only suggest vertical mixing but show the cross-channel gradients that exist in the water column. These gradients indicate dilution, rather than deposition, is the major process controlling SPM concentrations in the central part of the inlet.

Only part of the solids in the drilling muds and cuttings discharged into Cook Inlet may accumulate on the seafloor in the vicinity of the discharge. The bottom currents in lower Cook Inlet are strong enough to prevent the deposition of sand-size and smaller particles (Sharma, 1979; Hampton, 1982). The surface sediments in Shelikof Strait range from muddy sand in the northeast to sandy mud in the southwest and indicate sorting by present-day transporting currents (Hampton, et al., 1981).

As shown in Figure III.A.2-5, the flow of CI/SS water generally is to the southwest. Discharged substances that are dissolved or remain in suspension generally would be transported out of CI/SS and into the Gulf of Alaska.

During the drilling of a 12,000-ft well, mud weights may range from 9 to 15 lb/gal (about 1,080-1,800 gal per liter [g/l]) (Adams, 1985). The NRC (1983) notes that the vast majority of the drilling muds discharged into OCS waters have densities that range from 1.19 to 2.09 gal per cubic centimeters (g/cm^3) (≈ 1,190-2,090 g/l). For the purpose of this analysis, it is assumed the density of the drilling muds discharged into CI/SS could range from about 1,000 to 2,000 g/l. The particulate concentrations of the drilling discharges are expected to be greater than the chronic criteria, 100 to 1,000 mg/l, assumed for this analysis within about 100 m of the discharge point. With a dilution rate of 10,000:1, the concentration of drilling mud initially would be reduced to 0.10 to 0.20 g/l (100-200 mg/l) within 100 m of the discharge site; a dilution rate of 1,000,000:1 would reduce the concentrations to 0.001 to 0.002 g/l (1-2 mg/l) within 200 m of the discharge site. Rapid settling of the heavier particles would result in greater reductions in the concentrations of the drilling muds inside the 100- and 200-m mixing zones than were estimated by using only the dilution factors. The concentration of SPM in the water column of lower Cook Inlet ranges from 1 to 50 mg/l (Sec. III.A.3(b)(3)). Thus, within about 100 to 200 m of the discharge site, the concentration of particulate matter in the muds and cuttings discharged into the water column is expected to be reduced to levels comparable to the levels of naturally occurring SPM.

The drilling muds currently used in Cook Inlet generally are of low toxicity (AOGA, 1991; Neff, 1991). Toxicity is the inverse of the LC_{50}; as the LC_{50} value increases, the toxicity associated with the substance decreases. For example, a substance with an LC_{50} of 1 million ppm is less toxic than a substance with an LC_{50} of 3,000 ppm. The classification of relative toxicity of chemicals to marine organisms proposed by the IMCO/FAO/UNESCO/WHO, reported in Neff (1991), provides a means of qualitatively assessing relative toxicities. Concentrations <1 mg/l (or ppm) are classified as very toxic, 1 to 100 mg/l are toxic, 100 to 1,000 mg/l are moderately toxic, 1,000 to 10,000 mg/l are slightly toxic, and >10,000 mg/l are practically nontoxic. The toxicity (96-hr LC_{50}) of the muds used to drill 39 production wells in Cook Inlet between August 1987 and February 1991 ranged from 1,955 to >1,000,000 ppm for a marine shrimp (AOGA, 1991; Neff, 1991). The percentage of the wells with toxicities (1) >100,000 ppm was 79 percent, (2) between 10,000 and 100,000 ppm was 10 percent, and (3) between 1,000 and 10,000 ppm was 10 percent; concentrations >10,000 ppm are practically nontoxic and between 1,000 and 10,000 ppm are slightly toxic.

2) **Other Discharges:** In addition to the drilling muds and cuttings, there are a variety of other permitted discharges associated with exploration drilling that may be released into the waters of CI/SS; the characteristics of these discharges are summarized in Appendix J. The types and volume ranges of the discharges for exploration wells drilled in other Alaskan OCS planning areas are shown in Table IV.B.1.a-3. Many of these discharges also are associated with production operations, and the types and amounts of additives in the discharges associated with exploration-drilling operations are assumed to be similar to the production-related discharges. The types of compounds and the amounts that might be used in drilling-related discharges are shown in Table I.B.1.a-3. The types and amounts of compounds used will vary with each operation, and the information shown in the table is presented as possible examples. Dispersion in the receiving waters would further decrease the concentration of any additives. Seawater is the principal component of most of the discharges—in some cases it is the only constituent.

Sanitary and domestic wastes are monitored in accordance with the NPDES permit. Sanitary wastes mean human body waste discharged from toilets and urinals; domestic wastes includes wastes from showers, sinks, galleys, and laundries (USEPA, 1986). Sanitary and domestic wastes could range from 3,000 to 6,000 gallons per day (gpd) and 4,000 to 7,000 gpd, respectively (Table IV.B.1.a-3). Any facility using a marine-sanitation device that complies with pollution-control standards and regulations under Section 312 of the Federal Water Pollution Control Act, as amended, shall be deemed to be in compliance with the discharge limitations of the NPDES permit (USEPA, 1986).

As noted in Appendix J, these discharges (other than muds and cuttings) are expected to represent only small pollutant loadings when properly designed and functioning equipment is used. Dilution rates for some of the other discharges may be less than those estimated for the drilling muds. As will be discussed in Section IV.B.1.a(1)(b), the dilution rates for produced waters have been estimated to range from 1,020:1 to 1,550:1.

3) **Summary of Effects of Drilling Muds and Cuttings and Other Discharges on Water Quality:** The discharge of drilling muds and cuttings and other discharges associated with exploration drilling are not expected to have any effect on the overall quality of the Cook Inlet water. Within a distance of between 100 and 200 m from the discharge point, the turbidity caused by SPM in the discharged muds and cuttings is expected to be diluted to levels that are less than the chronic criteria (100-1,000 mg/l) and within the range associated with the variability of naturally occurring SPM concentrations. Mixing in the water column would reduce the toxicity of the drilling muds that, in general, are practically nontoxic, to levels that would not be harmful to organisms in the water column. In general, the amounts of additives in the other discharges are expected to be relatively small (from 1 to 100 or 200 g/month) and diluted with seawater several hundred to several thousand times before being discharged into the receiving waters.

(b) **Development and Production:** As part of the development and production phase of the base case, three oil-production platforms would be installed in the sale area; one platform each year would be installed in 1999, 2000, and 2001 (Tables IV.A.1 and 2). From these platforms, 48 production and service wells would be drilled using one to two drilling rigs. During the first year (2000), 10 wells would be drilled using one rig. In years 2000 and 2001, 20 and 18 wells would be drilled, respectively, using two rigs. Production is estimated to begin in 2003 and continue through 2021 and, during the 19-year production life of the platform, an assumed 200 MMbbl of oil would be produced (Table IV.A.2). Production would peak from 2004 through 2008, when 17 MMbbl of oil would be produced each year (Table IV.A.2). The water-quality effects associated with the operation of a Sale 149 production platforms are assumed to begin in 2000 with the drilling of the production and service wells and last through 2021 the last year of the estimated production period; this time period is estimated to be about 22 years.

Table IV.B.1.a-3
Estimates of Exploration-Well Drilling Discharges (Alaska OCS Waters)[1], Additives and Usage Rates[2]

Discharge Category	Discharge Rates (GPD--Gallons /Day)	Type of Compound Used	Usage Rates (GPM-Gallons/Month)
Drill Cuttings and Washwater	200,000 to 220,000 GPD		
Deck Drainage	1,000 to 25,000 GPD	All Purpose or General Cleaners (Biodegradable surfactants or aromatic hydrocarbon mixtures)	Range 2 - 400 GPM General 15 - 150 GPM
		Water Purifiers	<3 GPM
		Corrosion Inhibitors	1 - 2 GPM
		Biocides	4 - 20 GPM
Sanitary Wastes	3,000 to 6,000 GPD		
Domestic Wastes	4,000 to 7,000 GPD		
Desalination Wastes	3,700 to 20,000 GPD	Cleaners	up to 300 GPM
		Water Purifiers	<2 GPM
		Acidifier/Scale Removers	<15 lb/month
Blowout-Preventer Fluid	50 to 100 GPD		
Boiler Blowdown	100 to 200 GPD	Corrosion Inhibitors	1.5 - 3 GPM
		Oxygen Scavengers	1.5 - 3 GPM
Fire Control System Test Water	100,000 -- 12 times a month	Biocides	10 GPM
		Antifoam Additives	2 GPM
Noncontact Cooling Water	1,300,000 to 3,500,000 GPD	Biocides	4 - 240 GPM
		Water Purifiers	<2 GPM
		Oxygen Scavengers	3.5 lb/month
		Surfactants	27-52 GPM
Uncontaminated Ballast Water	2,000 to 80,000 GPD		
Uncontaminated Bilge Water	8,000 GPD		
Excess Cement Slurry	750 to 7,500 ft^3 -- 4 times		
Muds, Cuttings, Cement at Seafloor	100,000 to 175,000 Gallons		

Sources:

[1] AMOCO Production Co., 1985. Exploration Plan for Navarin Basin, OCS Sale 83 Area, Bering Sea, Alaska, January 1985.
AMOCO Production Co., 1985. Exploration Plan for Diapir Field, OCS Sale 87 Area, Beaufort Sea, Alaska, April 1985.
AMOCO Production Co., 1987. Plan of Exploration for Proposed Exploratory Drilling Operations in the eastern Beaufort Sea, OCS Lease Sale 87 Area, Offshore Alaska, April 1987.
ARCO Alaska, Inc., 1982. Exploration Plan and Environmental Report for the Eastern Gulf of Alaska, OCS Lease Sale No. 55,April 1982.
Atlantic Richfield Co., No Date. Exploration Plan and Environmental Report for Lower Cook Inlet.
ENSR Consulting and Engineering, 1990. Exploration Plan, OCS Lease Sale Areas 109 and 97, Chukchi and Beaufort Seas, Alaska. Prepared by ENSR Consulting and Engineering for Texaco Producing Inc., Anchorage, Alaska, April 1990.
Harding Lawson Associates, 1990. Exploration Plan, West Maktar Prospect, Beaufort Sea, Alaska. A report prepared by Harding Lawson Associates for Chevron U.S.A. Inc., Anchorage, Alaska, July 1990.
Northern Technical Services, 1984. Exploration Plan for St. George Basin, OCS Sale 70 Area, OCS-Y-0461, OCS-Y-0465, Bering Sea, Alaska. Prepared by Northern Technical Services for Placid Oil Company, Anchorage, Alaska, May 1984.
SWEPI, 1985. Exploration Plan for OCS Sale 87 Area, Beaufort Sea, Alaska. Shell Western Exploration and Production, Inc., February 1985.
SWEPI, 1985. Exploration Plan for OCS Sale 87 Area, Beaufort Sea, Alaska. Shell Western Exploration and Production, Inc., March 1985.

[2] EBASCO Environmental, 1990

Operations associated with the drilling of production and service wells and oil production generate a variety of permitted discharges that include drilling muds and cuttings, produced waters, and various other discharges that are summarized in this section; these discharges may be intermittent or continuous. The production discharges often contain a variety of chemicals used to improve or restore production, prevent or inhibit the growth of bacteria, inhibit corrosion and the formation of scale, improve separation of oil from water, and to clean facilities.

Between April 10, 1987, and April 10, 1988, the petroleum companies operating the oil- and gas-production facilities in upper Cook Inlet conducted a monitoring program (Cook Inlet Discharge Monitoring Study) to identify (1) the various types and amounts of chemicals used and discharged, (2) the characteristics of certain waste streams, and (3) the acute toxicity to marine life of the produced waters (EBASCO Environmental, 1990b). The information from this monitoring program, and other sources, is used to evaluate the characteristics and effects of some of the discharges that could be released from the Sale 149 production platforms. Although the monitoring program was conducted about 20 years after production began in Cook Inlet, the information it provides is associated with a variety of reservoir conditions and crude-oil-production rates that, in 1990, the Alaska Oil and Gas Association (AOGA, 1991) estimated to range from 300 to 6,800 bbl per day for the 14 oil-production platforms (Table III.A.5-9); average produced water outputs ranged from 30 to 40,300 bbl/day.

1) **Drilling Muds and Cuttings:** During the drilling of production and service wells, the discharge of drilling muds and cuttings is expected to introduce, on a dry-weight basis, an estimated 80 to 370 tons of drilling-mud components and 560 tons of cuttings per well into the marine environment (Table III.A.5-12); the drilling of the production and service wells from the same platform involves recycling some of the drilling muds to drill subsequent wells and this amount varies from well to well. The total dry-weight discharges from drilling 48 production and service wells are estimated to be between 3,840 and 17,760 tons of drilling-mud components and 26,880 tons of cuttings during a 2- to 3-year-drilling period (Table IV.B.1.a-2).

The characteristics of drilling mud use and the discharge of the muds and cuttings during the drilling of the production and service wells basically would be the same as those described for the drilling of the exploration wells as previously described in Section IV.B.1.a(1)(a)1).

As noted in Section IV.B.1.a(1)(a)3), the discharge of drilling muds and cuttings is not expected to degrade Cook Inlet water quality.

2) **Produced Waters:** The discharge of produced waters also is an issue of significant concern because of the types and amounts of naturally occurring substances they may carry and the manmade substances that may be added. Produced waters constitute the largest source of substances discharged into the marine environment. These waters are part of the oil/gas/water mixture produced from the wells and contain (1) a variety of substances dissolved from the geologic formations through which they migrated and in which they became trapped and (2) the soluble fractions of any hydrocarbons they might have encountered. The mixtures produced from the wells also may contain substances added to the waters injected into the producing formations and may contain chemicals added during the oil/gas/water separation process (EBASCO Environmental, 1990a, 1990b; Envirosphere Company, 1987).

Additives to the injection waters might include flocculants, oxygen scavengers, biocides, cleansers, and corrosion inhibitors; the types and amounts of additives used will depend on the reservoir and production conditions. During the CI Discharge Monitoring Study of production platforms in Cook Inlet in 1987 and 1988, the types of additives added to the injected waters varied among the platforms and the amounts ranged from <10 to 360 gallons per month per platform (EBASCO Environmental, 1990a).

A variety of chemicals may be added to the oil/water separation process to aid in separating the oil and gas from the water. The most commonly used types of compounds added to the production stream include scale inhibitors, emulsion breakers, biocides, and corrosion inhibitors. During the CI Discharge Monitoring Study of production platforms in Cook Inlet, the types of additives added to the oil/gas separation process varied and the amounts ranged from <1 to about 110 gpd per platform (EBASCO Environmental, 1990a). The concentration and toxicity ranges of some of the produced water treatment additives are noted in Section III.A.5.d(2)(c).

Over the life of a field, the volume of formation waters produced may be equal to 20 to 150 percent of the oil-output volume (Collins et al., 1983). As oil is pumped from a field, the ratio of water to oil being produced increases. For example, in 1970, several years after production began, the Cook Inlet fields were producing between 0.02 to 0.1 bbl of water per barrel of oil; whereas in 1990, these fields were producing between 0.4 to 5.5 bbl of water per barrel of oil (State of Alaska, Dept. of Natural Resources, Div. of Oil and Gas, 1970; State of Alaska, AOGCC, 1990).

Following 1990, the ratio of the total amount of water produced to the total amount of oil produced from the Cook Inlet oil fields ranged from about 0.09 to 0.74 (State of Alaska, AOGCC, 1990). Based on these ratios, the amount of water produced as a consequence of producing 200 MMbbl of oil might range from about 18 to 148 MMbbl or more; during peak oil production, 17 MMbbl/year, the annual amount of produced waters might range from 1.53 to 12.58 MMbbl (4,192 to 34,665 bbl/day).

a) **Characteristics of the Produced Waters:** Some of the characteristics of the produced waters that might be expected from Sale 149 are based on the characteristics of waters produced between April 1987 and April 1988 from the Cook Inlet platforms (CI Discharge Monitoring Study, Sec. IV.B.1.a(1)(b)). These characteristics are shown in Table III.A.5-13; measurements of the discharge were taken from the discharge streams prior to mixing with the receiving waters of CI/SS.

As noted in Section III.A.5.d(1), the treatment process removes suspended oil particles from the waters but the effluent contains dissolved hydrocarbons or those held in colloidal suspension. The treated produced waters contain the more soluble low molecular weight saturated and aromatic hydrocarbons.

The toxicity of produced waters mainly is caused by hydrocarbons (Brown et al., 1992). On this basis, the analysis of the effects of produced-water discharges focuses on nonvolatile hydrocarbons (USEPA oil and grease) and total aromatic hydrocarbons, two of the characteristics measured in the CI Discharge Monitoring Study that can be related to water-quality criteria. Other characteristics of the produced waters discussed in this section are based on those features that also can be related to water-quality criteria or compared to existing parameters in the water column. These characteristics include toxicity, pH, salinity, biological oxygen demand (BOD), and zinc concentration. It is assumed other constituents in the produced waters or the constituents in other discharges generally will be affected in a manner similar to one of the constituents analyzed in this section. As noted with the discharge of drilling muds, the effects of mixing the discharged produced waters with the receiving waters are to dilute the concentrations of the substances in the discharge.

Hydrocarbons:

Hydrocarbon Water-Quality Criteria: The State of Alaska (1989) water-quality criteria (marine-water uses) for the growth and propagation of fish, shellfish, aquatic life and wildlife states:

> Total hydrocarbons in the water column shall not exceed 15 μg/l or 0.01 of the lowest measured continuous flow 96 hour LC_{50} for life stages of species identified by the department as the most sensitive biologically important species in a particular location whichever concentration is less. Total aromatic hydrocarbons in the water column shall not exceed 10 μg/l, or 0.01 of the lowest measured continuous flow 96 hour LC_{50} for life stage of species identified by the department as the most sensitive biologically important species in a particular location whichever concentration is less (15 μg/l ≈ 0.015 ppm ≈ 15 parts per billion [ppb]).

The water-quality criteria is intended to represent the water-soluble or water-accommodated fraction of a crude or refined oil similar to that used in many laboratory acute and chronic toxicity tests (State of Alaska, Dept. of Environmental Conservation [ADEC], 1992a; as reported in Neff and Douglas, 1994). The water-soluble fraction includes primarily low molecular weight aromatic hydrocarbons; such as benzene, toluene, ethylbenzene, and xylenes; with lesser amounts of naphthalene, alkylnaphthalenes, phenanthrene, and light aliphatic hydrocarbons.

The USEPA (USEPA, 1991) water-quality criteria for marine waters do not include the total hydrocarbon nor total aromatic categories found in the State criteria. Instead, the USEPA criteria include (1) criteria for oil and grease and (2) concentrations for both acute and chronic criteria for the individual hydrocarbons.

Under the general NPDES (Cook Inlet/Gulf of Alaska) discharge permit for nonvolatile hydrocarbons (oil and grease), the monthly average discharge limitation is 48 mg/l and the maximum daily discharge limitation is 72 mg/l (USEPA, 1986).

Information based on toxicity tests is used to establish criteria that may be considered a measure of water quality. Chronic toxicity tests measure the effects (sublethal) of substances on such factors as growth, development, reproduction, or behavior. Acute toxicity tests determine the concentration of a substance that causes the mortality (lethal effects) of some fraction of the test population (for example, half of the population in the LC_{50} test) during a certain period of time (usually 4 days—96 hr). Most of the information on toxicity is based on the results of acute toxicity tests and, where there are no chronic toxicity tests, an application or safety factor is used to extrapolate to probable sublethal effects. For most toxicants, the chronic toxicity is estimated to one hundredth (0.01) to one thousandth (0.001) of the acute toxicity. For this analysis, the acute criterion is assumed to be 100 times greater than the chronic criterion—which results in the chronic criterion being 0.01 of the acute criterion. The chronic criterion for total hydrocarbons, 15 μg/l, may range from about 10 to 75 times greater than the background level of total hydrocarbons ($\approx$0.2-1.5 μg/l) in Cook Inlet.

Nonvolatile Hydrocarbons (EPA Oil and Grease) and Total Aromatic Hydrocarbons (TAH's): Nonvolatile hydrocarbons (EPA oil and grease) consist of a variety of organic substances including hydrocarbons, fats, oils, and waxes (Table IV.B.1.a-1). The USEPA gravimetric method of determining oil and grease measures some classes of carbon compounds such as fatty acids, phenols, and related compounds (Table IV.B.1.a-1) that do not significantly contribute to the toxicity of produced waters (Brown et al., 1992). The fate of any petroleum hydrocarbons released into the water column along with the produced waters is expected to be similar to the fate of spilled oil in seawater, as described in Section IV.A.2; the discharged substances are affected by chemical and biochemical degradation processes, evaporation, and dissolution and dispersion.

The nonvolatile hydrocarbons (oil and grease) and TAH quantities assumed to be in the Sale 149 produced water discharges are based on the mean concentrations reported in the discharges for the three onshore production treatment facilities (Granite Point, Trading Bay, and East Foreland) shown in Table III.A.5-13. The mean concentrations of oil and grease ranged from about 19 to 36 mg/l and the TAH ranged from about 8 to 13 mg/l. For oil and grease this range is less than the USEPA's maximum daily limit of 72 mg/l and monthly average of 48 mg/l.

At concentrations of 19 to 36 mg/l, the amount of nonvolatile hydrocarbons (oil and grease) that might be discharged with the produced waters (18-148 MMbbl) into Cook Inlet during the estimated producing life (19 years—Table II.A.1) of the Sale 149 production platforms is estimated to range from 60 to 933 tons (about 17-269 lb/day average) (Table IV.B.1.a-2). During peak production (17 MMbbl of oil/year) the amount of nonvolatile hydrocarbons discharged in the produced waters might range from about 5 to 79 tons per year (28-435 lb/day); the amount is expected to be closer to the lower end of the range as peak production occurs early in the life of the field when the ratio of the volume of produced waters to the volume of oil in the produced waters usually is low.

The mean concentration of TAH in the produced waters from the treatment facilities ranged from about 8 to 13 mg/l (Table III.A.5-13). Using these concentrations, the aromatics that might be discharged with the produced waters (18-148 MMbbl) from the Sale 149 production platforms is estimated to range from about 25 to 337 tons (7-97 lb/day average) Table IV.B.1.a-2). During peak production the amount of TAH in the produced waters might range from 12 to 157 lb/day.

b) **Effects of Mixing:** When the produced waters reach the receiving waters of the mixing zone, the concentrations of the nonvolatile hydrocarbons and TAH are estimated to range from 19 to 36 mg/l (19,000-36,000 μg/l) and 8 to 13 mg/l (8,000-13,000 μg/l), respectively. Mixing of the produced waters with the receiving waters reduces the concentrations of the substances in the discharges. Based on modeling, the USEPA (reported in AOGA, 1990) has estimated dilution at the edge of the mixing zone for (1) production platforms in upper Cook Inlet to be 1,550:1 and (2) Trading Bay Production Facility to be 1,020:1. The radii of the mixing zones for the oil production platforms and the Trading Bay Production Facility are 625 and 750 m, respectively (USEPA, 1986); the corresponding areas of the mixing zone are 1.23 and 1.77 km^2, respectively. However, as noted for drilling-mud discharges, dilution rates were estimated to range from 10,000:1 to 1,000,000:1 within 100 to 200 m to the discharge point; these rates are about 6 to 980 times that estimated for the produced waters. Thus dilution rates might range from about 1,000:1 to 1,000,000:1.

The nonvolatile hydrocarbons (oil and grease) in the produced waters from an oil-production platform might be diluted 1,000 to 1,000,000 times within several hundred meters of the discharge source. If dilutions are based on a rate at the lower end of the range—1,000:1, the concentrations of nonvolatile hydrocarbons within several hundred meters of the platform might range from 19 to 36 μg/l, and the concentrations of TAH might range from 8 to 13 μg/l. These concentrations are well below the acute criteria of 1,500 μg/l for the nonvolatile hydrocarbons and 1,000 μg/l for the TAH that were assumed for this analysis but, in general, slightly greater than the chronic criteria of 15 μg/l for the nonvolatile hydrocarbons and 10 μg/l for the TAH. If dilution rates are about 10,000:1, the concentrations of nonvolatile hydrocarbons might range from about 2 to about 4 μg/l and the concentrations of TAH might be about 1 μg/l; these concentrations are less than the respective chronic criteria assumed for analysis. As noted in Appendix J, modeling of drilling muds and cuttings discharges in waters deeper than 40 m estimates that dilution rates for solids might range from about 1,000:1 to 6,000:1 and for dissolved substances from about 1,000:1 to 27,000:1.

Mixing is a continuous process, and the rate will depend on the receiving environment's energy as derived from the currents and waves. Evaporation will remove some of the aromatic hydrocarbons from the water column; Jordan and Payne (1980) note that evaporation may remove the majority of the more volatile compounds within 24 to 28 hours after an oil spill. Also, biodegradation processes act to continuously change the hydrocarbon compounds in the waters.

c) **Some Other Characteristics of Produced Waters:** Other characteristics of the produced waters discharged from the upper Cook Inlet production platforms shown in Table III.A.5-13 include pH, salinity, BOD, and zinc concentration. The mean pH (field) ranged from 6.5 to 7.5; the general NPDES permit discharge limitation ranges from 6 to 9 (USEPA, 1986). The pH of surface seawater generally is about 8.2 (Millero and Sohn, 1991). The mean salinity of the produced waters from the treatment facilities ranged from about 21 to 34 ‰ and from the platforms about 5 to 14 ‰. As noted in Section III.A.4.a(1), the salinities in lower Cook Inlet range from about 26 ‰ at the Forelands to 32 ‰ at the entrance and about 32 ‰ in Shelikof Strait; salinities near the mouths of rivers and streams may be about 5 ‰.

Zinc and BOD amounts discharged from the production platforms can be compared with the amounts found in other discharges; the volume of produced waters is estimated to range from 18 to 148 MMbbl for the 19-year production life (Table IV.B.1.a-2). The amount of zinc discharged into Cook Inlet waters is estimated to range from about 0.1 to 11 tons (about 0.03-3.14 lb/day average) (Table IV.B.1.a-2). This estimate is based on the mean concentration of zinc in the produced-water samples from the production-treatment facilities in upper Cook Inlet, Table III.A.5-13, which ranged from 0.03 to 0.42 mg/l (≈ 0.03-0.42 ppm). The concentration of zinc in the waters (1) from the Matanuska, Knik, and Susitna Rivers range from 106 to 186 ppm and (2) of lower Cook Inlet from 165 to 352 ppm (Table III.A.5-4).

The discharged BOD might range from about 1,303 to 13,435 tons (376-3,874 lb/day average) (Table IV.B.1.a-2); the mean BOD concentration in the produced-water samples associated with upper Cook Inlet oil production ranged from 413 to 518 mg/l (Table III.A.5-13). During peak production the amount of BOD in the produced waters might range from 607 to 6,257 lb/day. In 1993 the BOD in effluent discharge from the Anchorage Water and Wastewater Utility Point Woronzof Wastewater Treatment Facility averaged about 25,800 lb/day (Sec. III.A.5.d(2)(a)).

d) **Toxicity:** The toxicity of the produced waters from the oil and gas fields of upper Cook Inlet was determined by using a standard 96-hour static acute-toxicity test to the mysid shrimp *Mysidopsis bahia* (EBASCO Environmental, 1990a); this test measures the concentration killing 50 percent of the test animals in 96 hours (96-hour LC_{50}). (*Mysidopsis bahia* has been routinely used to evaluate the toxicity of effluents from municipal wastewater-treatment plants, refineries, and chemical manufacturing plants to marine organisms [Brown et al., 1992]). The 96-hr LC_{50} toxicities of the produced waters ranged from 0.27 to 82.47 percent of the effluent (Table III.A.5-13); these concentrations equal 2,700 to 824,700 ppm. Based on the qualitative toxicity levels described in Section IV.B.1.a(1)(a), the produced waters sampled during the CI Discharge Monitoring Study Program would range in toxicity from slightly toxic to practically nontoxic prior to discharge and subsequent mixing in the water column.

Summary of Effects of Produced-Water Discharge on Water Quality: The discharge of produced waters is not expected to degrade the quality of Cook Inlet water. Mixing and weathering processes continuously will reduce the concentrations of the hydrocarbons in the produced waters. Mixing is expected to reduce the concentrations of the nonvolatile hydrocarbons and TAH's to concentrations that are less than the chronic criteria of 15 μg/l and 10 μg/l, respectively. Also as noted in Section III.A.5.c(4)(c) the concentrations of any of the various types of hydrocarbons in the water column generally are quite low or below detection limits. The pH of the produced waters is expected to be within the range specified by the USEPA. The salinities of the produced waters would be within the range of salinities that are found in Cook Inlet. The discharge of metals, as indicated by zinc, generally would be less than the amounts streams and rivers discharge into Cook Inlet. Mixing in the water column would reduce the toxicities of the produced waters which, in general, may range from slightly toxic to practically nontoxic prior to discharge.

3) **Other Discharges:** The characteristics of some of the other permitted discharges associated with oil- and gas-production activities in State of Alaska waters of Cook Inlet are summarized in Section IV.B.1.a(1)(a)2). The effects of these discharges on Cook Inlet water quality are expected to be the same as described for exploration drilling—here would be no degradation of water quality.

4) **Comparisons:** Comparisons of some of the estimated base case discharges with estimated discharges from streams and rivers and from other point source discharges are shown in Table IV.B.1.a-4.

(2) **Oil Spills:** It is estimated that accidental oil spills may occur in the sale area if oil is produced as a result of Sale 149; no spills are assumed to occur during the drilling of the exploration wells (Tables IV.A.2-4a). Based on OCS production-spill data, the production of an assumed 200 MMbbl of oil is estimated to result in 49 small spills (<1,000 bbl), which would release an estimated 555 bbl (Table IV.A.2-4d) of oil into the water and one assumed large (≥1,000 bbl) spill of 50,000 bbl (Table IV.A.2-2). The analysis of the effects of these spills on water quality does not consider the effects oil-spill-cleanup measures could have in reducing the volume of oil that has been released into the water column; effectiveness of oil-spill-cleanup measures are discussed in Sections IV.A.3.a(5) and (6).

(a) **Fate of Petroleum in Seawater:** Petroleum released into seawater is exposed to a variety of physical, chemical, and microbiological processes that operate interdependently and simultaneously with each other to degrade and, eventually, remove it from the water column (Karrick, 1977). The fate of petroleum in seawater is discussed in Section IV.A.2. During the degradation process, some of the various constituents of the spilled oil will spread over the sea surface, evaporate into the atmosphere, disperse and dissolve into the water column, form water-in-oil emulsions, wash onto beaches and sink to the seafloor, and change by chemical and microbiological processes.

(b) **Oil Spills Less Than 1,000 Barrels:** Accidental oil spills may occur in the sale area if oil production (200 MMbbl) occurs as a result of Sale 149. As shown in Tables IV.A.2-4b and 4c, the size of oil spills <1,000 bbl may be categorized as spills (1) >1 but <50 bbl and (2) ≥50 but <1,000 bbl. For spills of <50 bbl, the number of spills for the base case is estimated to be 47, and the average size of these spills is about 5 bbl (Table IV.A.2-4b). For spills ≥50 bbl but <1,000 bbl, the number of spills is estimated to be two, and the average size of these spills is about 160 bbl (Table IV.A.2-4c).

In the summer, the size of the discontinuous area affected by the release of 5 bbl of oil into the waters of lower Cook Inlet is estimated to be about (1) 1.7 km^2 after 3 days, (2) 8.8 km^2 after 10 days, and (3) 34 km^2 after 30 days; the size of a whole OCS lease block is 23.04 km^2 (Table IV.A.3-3).

As a basis for comparing the effects of "small" and "large" spills on the water quality, the concentrations of oil that has been dispersed into the water column can be simply estimated by (1) using the amount of oil spilled and the estimated size of the affected area and (2) assuming a depth of mixing and homogeneity of dilution. The amount of oil spilled and the calculated spill size have been previously discussed. In addition to the assumptions used to calculate the size of the discontinuous area of the spill, the dispersed oil concentration estimates include the following additional assumptions for the base case: (1) the estimated amount of oil dispersed during summer into the water column after 3, 10, and 30 days is 25, 37, and 42 percent, respectively, of the amount spilled (Ford, 1985); (2) the extent of the discontinuous area estimated for the surface is assumed to extend into the water column; (3) the depth of mixing is assumed to be 5 m after 3 days, 10 m after 10 days, and 30 m after 30 days; and (4) the concentration of the dispersed oil is assumed to be uniform in the "mixed" watermass.

Table IV.B.1.a-4
Estimated Annual Freshwater and Point-Source Discharges into Cook Inlet

Discharge Source	Total Discharge(million gallons)	Suspended Sediments (million lb)	BOD or Organic Wastes (million lb)	Oil and Grease (million lb)	Settable Solids (million lb)	Zinc (lb)	Barium[1] (tons)	Mercury[2] (lb)	Cadmium[3] (lb)
Rivers (Total Table III.A.5-1)	18,520,000								
Knik, Matanuska, Susitna (Gold Creek)	14,484,000	80,123							
Susitna River (Gold Cr) Mean[4] Minimum Maximum	 2,352,000 1,320,400 3,071,700		(78)[5]			 196,300 110,200 256,300	149-487	<1,102-2,563	<11,018-779,690
Ninilchik River	285,500	7.43							
Municipalities									
Projected (based on 1993 data)[6]	10,950	4.48	9.41	1.96		6,486		36.5	
Seafood Processing7			5.56-18.92						
Produced Waters[8]									
State of Alaska									
Proven and Developed Fields [9] (104.2 MMbbl——5.48 MMbbl/year)	21-170		0.07-0.74	<0.01-0.05		5-597			
Sale 149 (Alternative I–Base Case (200 MMbbl–17 MMbbl/year [peak])	64-528		0.22-2.28	0.01-0.16		16-1,852			
Drilling Muds and Cuttings									
State of Alaska									
Proven and Developed Fields (11 wells/year)[10]		2.04			18.42		1,513	5	15
Sale 149 (Alternative I——Base Case [2001——20 wells])		2.56-3.72			23.04-33.48		595-2,750	2-9	6-28

[1] Based on dissolved barium in the Susitna River (Gold Creek) 27 to 38 μg/l.
[2] Based on dissolved mercury in the Susitna River (Gold Creek) <0.1 μg/l.
[3] Based on dissolved cadmium in the Susitna River (Gold Creek) <1 μg/l.
[4] Section III.A.5.b.
[5] Based on dissolved carbon in Susitna River (Gold Creek).
[6] Table III.A.5-7.
[7] Table III.A.5-8.
[8] Table III.A.5-11.
[9] Grainte Point, McArthur River, Middle Ground Shoal, and Trading Bay mean production for 19 years.
[10] Section III.A.5.d(2)(c).
[11] Table III.A.5-14.
[13] Section III.A.5.b

As noted previously, the waters of lower Cook Inlet generally are vertically well mixed and strongly influenced by the tidal cycle. The mean daily tidal range in lower Cook Inlet is assumed to be 5 m; the mean range at Seldovia, Nikishka, and Drift River Terminal is 5.5, 6.2, and 5.5 m, respectively (Brower et al., 1988). For the depth-of-mixing estimates, it is assumed the oil will be dispersed into the water column to a depth equivalent to the tidal range, 5 m, after 3 days; during this time interval, the area affected by the spill will have experienced six tidal cycles. At the end of 10 days, the oil is assumed to have dispersed to a depth of 10 m; during this time there will have been about 20 tidal cycles and two to three changes in the meteorologic events that affect wind-driven waves and surface currents. At the end of 30 days, the oil is assumed to have dispersed to a depth of 30 m; during this time there will have been about 60 tidal cycles and 7 to 10 changes in the meteorologic events that affect wind-driven waves and surface currents.

For a 5-bbl spill at the end of 3 days, the concentration of dispersed oil is estimated to be 20 μg/l in waters about 5 m deep and covering 1.7 km^2. With time, the size of the discontinuous area and the depth of mixing increases and the concentration of the dispersed oil decreases. The estimated concentrations of dispersed oil after (1) 10 days is 3 μg/l in waters 10 m deep and covering 8.8 km^2, and (2) 30 days is 0.3 μg/l in waters 30 m deep and covering 34 km^2.

The effects on water quality of a "small" summer spill $\geq$50 bbl are represented by the 160-bbl spill (Table IV.A.2-4c); the estimated amount of oil dispersed into the water column after 3, 10, and 30 days is 15, 30, and 39 percent, respectively (Table IV.A.3-3). Based on the same assumptions as used for the 5-bbl spill, estimates of the sizes of the discontinuous areas and concentration of oil dispersed from a 160-bbl spill indicate that after 3 days, the concentration of dispersed oil is estimated to be 61 μg/l in waters estimated to be 5-m deep and covering about 11 km^2. The estimated concentration of dispersed oil after (1) 10 days is 14 μg/l in waters 10-m deep and covering 48 km^2 and (2) 30 days is 1 μg/l in waters 30-m deep and covering 199 km^2.

The simplified estimates of the amount of dispersed oil in the water column indicate that the concentration of spilled oil, immediately after a spill, in a relatively small area may exceed the State of Alaska total hydrocarbon criterion of 15 μg/l; the concentrations are, however, below the acute criterion of 1,500 μg/l assumed for this analysis. However, the hydrodynamic processes act to continuously disperse the oil and dilute the concentrations. The other processes that degrade oil and remove it from the water column were ignored in the concentration estimates. The NPDES discharge permit limits on the amount of oil and grease (nonvolatile hydrocarbons) allowed in the produced waters discharged into the waters of upper Cook Inlet; the monthly average discharge limitation is 48 mg/l and the maximum daily discharge limitation is 72 mg/l (Sec. IV.B.1.b(2)(a)). Dilution in a mixing zone of some of the substances dissolved or suspended in discharges from petroleum-exploration-drilling units or production platforms could range from about 1,000:1 to 1,000,000:1 (Sec. IV.B.1.a(1)(b)2)b)). Although nonvolatile hydrocarbons in the produced waters are not the same as spilled crude oil in the waters of lower Cook Inlet, the dilution rates of produced waters in a relatively small area suggest dilution of spilled oil may be more rapid than is indicated by the estimates presented in this section for 5- and 160-bbl spills.

However, the area affected by spilled oil may differ from that predicted from wind, temperature, and wave-height conditions. The midchannel tide "rip" or convergence zone in lower Cook Inlet, Figure III.A.2-7, is an area where spilled oil, along with other floating debris, tends to accumulate (Whitney, 1994). In the central part of lower Cook Inlet between Kalgin Island and Port Graham, the chance that spilled oil would be transported into the midchannel convergence zone is estimated to be greater than 80 percent (Whitney, 1994). In the convergence zone, the size of the discontinuous area covered by an oil slick probably would be less than that assumed for this analysis and the concentration of oil greater.

Summary of Effects of Small Oil Spills ($\leq$1,000 bbl) on Cook Inlet Water Quality: Small oil spills, as represented in this analysis by 5- and 160-bbl spills, are not expected to have any degradational effects on the overall water quality of Cook Inlet. The small spills would degrade the water quality for a relatively short period of time, perhaps up to about 10 days, in areas of less than about 50 km^2. As noted in Section III.A.5.c(4)(e), the concentration of any of the various types of hydrocarbons in the water column generally are quite low or below detection limits. Also, the total organic compounds in the sediments of Cook Inlet are present in concentrations that indicate an unpolluted environment; the presence of hydrocarbons in the water column is transitory but they can accumulate in depositional sedimentary environments.

(c) **Oil Spills Greater Than or Equal to 1,000 Barrels:** For the base case, it is assumed that a spill ≥ 1,000 bbl will occur and the amount oil released by such a spill will be 50,000 bbl (Table IV.A.2-2); the OSRA model estimates a mean number of 0.31 spills ≥ 1,000 bbl are likely to occur as a result of this scenario, with an estimated 27-percent chance of one or more such spills occurring (Table IV.A.2-2).

In the summer at the end of 3 days, the estimated characteristics of a 50,000-bbl spill include (1) a discontinuous surface area covering an estimated 190 km^2, (2) about 10 percent of the volume spilled dispersing into the water column, and (3) about 67 percent of the volume originally spilled remaining in the slick (Table IV.A.3-1). Based on the assumptions used to estimate the dispersed oil concentration for a 5-bbl spill (Sec. IV.B.1.a(2)(b)), the concentration of dispersed oil after 3 days is estimated to be 711 $\mu g/l$; the dispersal depth is assumed to be 5 m. After 10 days, the slick would cover an estimated 912 km^2, 22 percent of the oil in the spill would be dispersed into the water column, and the amount of oil remaining in the slick is about 49 percent of the spilled volume (Table IV.A.3-1). The concentration of oil dispersed into the water is estimated to be 163 $\mu g/l$; the dispersal depth is assumed to be 10 m. After 30 days, the slick would cover an estimated 3,715 km^2, 34 percent of the oil in the spill would be dispersed into the water column, and the amount of oil remaining in the slick is about 35 percent of the spilled volume (Table IV.A.3-1). The concentration of oil dispersed into the water is estimated to be 21 $\mu g/l$; the dispersal depth is assumed to be 30 m.

If a spill occurred in winter in open water, the environmental conditions affecting the characteristics of a spill would be different than those of summer. The winter conditions are represented by colder water temperatures (4.76 °C), stronger winds (16 kn), and higher waves (1.8 m) than the summer condition (8.8-°C-water temperatures, 11.5-kn winds, and 1-m-wave heights) (Table IV.A.3-1). In the winter at the end of 3 days, the characteristics of a 50,000-bbl spill include (1) a discontinuous surface area covering an estimated 178 km^2, (2) about 12 percent of the volume spilled dispersing into the water column, and (3) about 65 percent of the volume originally spilled remaining in the slick (Table IV.A.3-1). The concentration of dispersed oil after 3 days is estimated to be 911 $\mu g/l$; the dispersal depth is assumed to be 5 m. After 10 days, the slick would cover an estimated 851 km^2, 27 percent of the oil in the spill would be dispersed into the water column, and the amount of oil remaining in the slick is about 46 percent of the spilled volume (Table IV.A.3-1). The concentration of oil dispersed into the water is estimated to be 214 $\mu g/l$; the dispersal depth is assumed to be 10 m. After 30 days, the slick would cover an estimated 3,458 km^2, 37 percent of the oil in the spill would be dispersed into the water column, and the amount of oil remaining in the slick would be about 33 percent of the spilled volume (Table IV.A.3-1). The concentration of oil dispersed into the water is estimated to be 24 $\mu g/l$; the dispersal depth is assumed to be 30 m.

When ice floes are present, the winter broken-ice conditions are represented by 16-kn winds, 0-°C-air temperatures, 1.8-m-wave heights, and the presence of ice floes covering 40 percent of the sea surface (Table IV.A.3-2). In broken-ice conditions at the end of 3 days, the oil from a large spill may be dispersed in a 170-km^2 area in concentrations of about 3,020 $\mu g/l$. The concentration of the dispersed oil 10 days after a spill is estimated to be about 400 $\mu g/l$ in an area of about 794 km^2 and after 30 days, 37 $\mu g/l$ in an area of about 3,311 km^2.

The high concentrations of oil associated with estimating dispersal in the water column may represent an upper range of dispersed oil concentrations reached during the first several days following a large spill. These concentrations are greater than the 15 $\mu g/l$ that was assumed to be the total hydrocarbon chronic criterion but less than the 1,500 $\mu g/l$ that was assumed to be the acute criterion. The concentration of oil (1) from the *Argo Merchant* (NRC, 1985) spill ranged from 90 to 170 $\mu g/l$ at the surface and up to 340 $\mu g/l$ in the water column (at several of the sampling stations, the concentrations were uniform to water depth of 20 m) and (2) from the *Amoco Cadiz* (Gundlach et al., 1983) spill ranged from 2 to 200 $\mu g/l$ in the nearshore area and 30 to 500 $\mu g/l$ in the estuaries. The *Argo Merchant* and *Amoco Cadiz* spills (NRC, 1985) were much larger; 0.18 and 1.6 MMbbl, respectively, than is the assumed 50,000-bbl (0.05 MMbbl) spill for the Sale 149 analysis. Both the summer and winter concentrations of oil that are estimated to dispersed in the water column after 10 days, 165 and 217 $\mu g/l$, respectively, are within the range of concentrations reported for the larger *Argo Merchant* and *Amoco Cadiz* spills. The concentration of dispersed oil in the water 30 days after both the summer and winter spills are greater than 15 $\mu g/l$ and indicate a relatively long period of time, perhaps about a month or more, before dilution of the dispersed oil reduces the concentrations below 15 $\mu g/l$.

As noted in Section IV.B.1.a(1)(b)), the hydrodynamic processes act to continuously reduce the concentrations. The other processes that degrade oil and remove it from the water column were ignored in the simplified concentration estimates. Also, as noted in the discussion in the preceding section regarding dilution rates of dispersed oil from small spills, dilution rates may be more rapid than are indicated by the estimates presented for large (≥ 1,000-bbl) spills.

Dilution in a mixing zone of some of the substances dissolved or suspended in discharges from petroleum-exploration-drilling units or production platforms could range from about 1,000:1 to 1,000,000:1 (Sec. IV.B.1.a(1)(b)2)b)). Thus, the concentrations of spilled oil dispersed in the water column may be reduced more rapidly than is indicated by the concentration estimates described previously.

The size of the 50,000 bbl spill beginning after a period of time as represented by either the 3- or 10-day interval and the proximity of land portends that the shorelines of Shelikof Strait are at risk of being contacted by spilled oil. The probabilities of spilled oil contacting the shorelines are described in Section IV.A.2.a(5)(b)1), and the fate of oil on the shorelines is described in Section IV.A.3.e.

Summary of the Effects of a Large Oil Spill (≥1,000) bbl) on Cook Inlet Water Quality: A large oil spill (≥ 1,000 bbl), as represented in this analysis by a spill of 50,000 bbl of crude oil, would degrade the quality of Cook Inlet water for a period of about a month or longer in an area that might extend over several thousand square kilometers. If the spill occurs within a relatively short period of time, as measured in hours, the hydrocarbon concentration in the water column generally is expected to be less than the acute criterion (1,500 μg/l) within several days. However, the hydrocarbon concentration may remain greater than the chronic criterion (15 μg/l) for a month, or more.

(3) **Construction Activities:** The construction activities that potentially could affect the water quality in Cook Inlet would be associated with laying on the sea floor a trunk pipeline used to transport oil from the production platforms to the shore (Appendix A). As noted in Section II.A.3.c, the base case assumes a 125-mi pipeline will be used to transport oil from the production platforms to an oil-storage and -terminal facility located on the western side of the Kenai Peninsula; the pipeline-laying operations are assumed to take about 6 to 8 months. The SPM concentration in the waters of lower Cook Inlet range from about 1 to 50 mg/l and consists, in part, of particulate matter resuspended by tidal currents and wind-driven waves and currents. The concentration of resuspended particulate matter in the water column from pipeline-laying operations may be greater than the natural SPM concentration downcurrent from the operations. However, the turbulence caused by the tidal and other currents will dilute the concentrations of the resuspended particulates; the ratios of dilution could range from 10,000:1 to 1,000,000:1 within 100 to 200 m downcurrent of the pipeline-laying operations. Construction activities are not expected to have any overall degradational effects on Cook Inlet water quality.

Summary: The activities associated with petroleum exploitation that are most likely to affect water quality for Alternative I (base case) are (1) the permitted discharges from exploration-drilling units and production platforms, (2) oil spills, and (3) construction activities. The hydrodynamic processes in the Cook Inlet Planning Area suggest the water column generally is well mixed, and dilution would reduce the concentration of the substances in the discharges. Degradation processes also act to continuously reduce the concentrations of many substances deliberately or accidentally released into the environment.

Of the permitted discharges, drilling muds and cuttings and produced waters are the most significant discharges associated with offshore operations. The permitted discharges would add substances that may be foreign to or increase the concentration of constituents already present in the water column of CI/SS. In general, the added substances may cause sublethal effects in some marine organisms if concentrations are greater than the chronic criteria (for the protection of marine life) and lethal effects if concentrations are greater than acute criteria.

Drilling of the 3 exploration, 5 delineation, and 48 production and service wells could result in the discharge of an estimated 6,720 to 20,640 tons (dry weight) of drilling-mud components and 30,400 tons (dry weight) of cuttings over a 6-year period. The concentrations of discharged drilling muds initially may range from about 1,000 to 2,000 g/l and are expected to be greater than the SPM chronic criteria, 100 to 1,000 mg/l, assumed for this analysis within about 100 m of the discharge point. However, within about 100 to 200 m of the discharge point, mixing in the water column would reduce the concentrations by a factor of 10,000 to 1,000,000; the diluted concentrations are estimated to range from 1 to 200 mg/l. The SPM concentration in lower Cook Inlet ranges from about 1 to 50 mg/l. The toxicity of the drilling muds generally is low and the concentrations of the bulk constituents become nontoxic at the dilutions reached shortly after discharge. Most of the solids in the discharges settle rapidly to the seafloor, where bottom currents disperse the finer particles.

The discharge of drilling muds and cuttings is not expected to degrade the overall quality of Cook Inlet water.

Produced waters constitute the largest source of substances discharged into the marine environment and their discharge is an issue of significant concern because of the types and amounts of naturally occurring substances they may carry and the manmade substances that may be added. The amount of produced water that would be discharged as a consequence of producing an assumed 200 MMbbl of oil in 19 years is estimated to range from about 18 to 148 MMbbl. The toxicity of produced waters mainly is caused by hydrocarbons that include nonvolatile hydrocarbons (EPA oil and grease) and aromatic hydrocarbons.

The concentrations of nonvolatile hydrocarbons and TAH in the produced waters are estimated to range from 19 to 36 mg/l (19,000-36,000 μg/l) and 8 to 13 mg/l (8,000-13,000 μg/l), respectively. The TAH concentration is 8 to 13 times greater than the acute criteria, 1,000 μg/l, assumed for this analysis.

The dilution rates for the produced waters are estimated to range from about 1,000:1 to 1,000,000 within several hundred meters of the discharge site. If dilutions are based on a rate of 1,000:1, the concentrations of nonvolatile hydrocarbons within several hundred meters of the platform might range from 19 to 36 μg/l and the concentrations of TAH might range from 8 to 13 μg/l. These concentrations are well below the acute criteria of 1,500 μg/l for the nonvolatile hydrocarbons and 1,000 μg/l for the TAH that were assumed for this analysis but, in general, slightly greater than the chronic criteria of 15 μg/l for the nonvolatile hydrocarbons and 10 μg/l for the TAH. If dilution rates are about 10,000:1, the concentrations of nonvolatile hydrocarbons might range from about 2 to about 4 μg/l, and the concentrations of TAH might be about 1 μg/l; these concentrations are less than the respective chronic criteria assumed for analysis. When discharged, the toxicity of the produced waters is expected to range from slightly toxic to practically nontoxic and will decrease with continued mixing in the water column.

The discharge of metals, as indicated by zinc, generally would be less than the amounts streams and rivers discharge into Cook Inlet. The characteristics of the other constituents of the produced waters or other production-related discharges are expected to be within the USEPA criterion and/or be diluted in the water column within an area <2 km^2 to background concentrations or levels that would not cause sublethal to lethal effects in marine organisms.

The potential effects in any of the areas where there are permitted discharges would last for about (1) 3 to 4 months for each exploration well drilled and (2) 21 years for development and production activities. Future procedures and technologies of treating and handling drilling muds and cuttings and produced waters may reduce or eliminate the amounts discharged.

The routine discharges associated with oil production are not expected to cause any overall degradation of Cook Inlet water quality.

Accidental oil spills introduce into the water column a variety of hydrocarbon compounds whose concentrations may cause sublethal to lethal effects in marine organisms. Hydrodynamic and meteorological forces increase the areal extent of the spill, and physical, chemical, and microbiological forces degrade the oil and reduce its concentration and toxicity.

The number of small ($<1,000$-bbl) accidental oil spills that might occur if oil is produced is estimated to be 49; the total volume of oil spilled is estimated to be 555 bbl (47 spills that average 5 bbl in size and 2 spills that average 160 bbl in size). At the end of 3 days assuming no cleanup, the oil from a small spill may be dispersed in a 1- to 10-km^2 area in concentrations of about 20 to 61 μg/l. The concentration of the dispersed oil 10 days after a spill is estimated to be between 3 and 14 μg/l in an area of about 9 to 48 km^2 and after 30 days, <1 to about 1 μg/l in an area of 34 to 199 km^2. During the 3- to 30-day interval following a small spill, the concentration of oil in the water column is not expected to exceed the total hydrocarbon acute criterion, 1,500 μg/l, assumed for this analysis; however, the concentration of spilled oil is expected to exceed the assumed total hydrocarbon chronic criterion, 15 μg/l, for several days to weeks.

Accidental small oil spills (< 1,000-bbl) are not expected to cause any overall degradation to the quality of Cook Inlet water.

There is a 27-percent chance that a spill ≥ 1,000 would occur, but if it did, the size of the spill is estimated to be about 50,000 bbl. For a summer spill the concentration of total hydrocarbons in the water column from a large spill is not expected to exceed the chronic criterion (15 μg/l), at least after 3 days, but may exceed the acute criterion (1,500 μg/l) for more than 30 days. In the summer at the end of 3 days assuming no cleanup, the oil from a large spill may be dispersed in a 190-km^2 area in concentrations of about 711 μg/l. The concentration of the dispersed oil 10 days after a spill is estimated to be about 163 μg/l in an area of about 912 km^2 and after 30 days, 21 μg/l in an area of about 3,714 km^2.

If the spill occurred in the winter, the size of the affected areas after the 3-, 10-, and 30-day time intervals would be less than for a summer spill, but the concentration of oil in the water column would be greater. The oil in the water column is not expected to exceed the total hydrocarbon acute criterion (1,500 μg/l) during the (1) 3- to 30-day interval following a large spill under open-water conditions and (2) 10- to 30-day interval after a large spill in broken ice. During the 3- to 10-day interval following a large spill the oil in the water column is expected to exceed the total hydrocarbon acute criterion (1,500 μg/l) under broken ice conditions. The concentration of total hydrocarbons in the water column during the winter may exceed the acute criterion (15 μg/l for > 30 days.

A large oil spill (≥ 1,000 bbl) would degrade the quality of Cook Inlet water for a period of about a month or longer in an expanding area that might extend over several thousand square kilometers.

Construction activities would increase the turbidity in the water column along segments of a 125-mi corridor for about 2 to 4 months, but there would be no overall water quality degradation.

Conclusion: The permitted, routine discharges associated with oil and gas development and small (< 1,000 bbl) oil spills are not expected to cause any measurable overall degradation of Cook Inlet water quality. Water quality would be reduced from good (unpolluted) to polluted by the presence of hydrocarbons from one or more large (≥ 1,000 bbl) oil spills that have a relatively low chance (27%) of occurring. Contamination (the presence of hydrocarbons in amounts > 15 μg/l) would be temporary (last for a month, or more) and affect an area of several thousand square kilometers.

b. **Effects on Lower Trophic-Level Organisms:** Lower trophic-level communities (phytoplankton, zooplankton, and benthic) in the lower Cook Inlet area are described in Section III.B.1. In the base case, both exploration and production are assumed to occur in Cook Inlet. Routine activities associated with this alternative that may affect lower trophic-level organisms include seismic surveys, drilling discharges, and construction (discussed below). Accidental activities include exposure to petroleum-based hydrocarbons from an oil spill. Because a pipeline or tanker spill (the primary sources of an oil spill) originating in Cook Inlet is likely to contact the Shelikof Strait area as well, Shelikof Strait also is included for purposes of analysis.

The effects of these agents/activities on lower trophic-level organisms have been discussed in the EIS's for Lower Cook Inlet Proposed Oil and Gas Lease Sale CI (USDOI, BLM, 1976) and Norton Basin Sale 100 (USDOI, MMS, Alaska OCS Region, 1985), as well as in Davenport, 1982; Howarth, 1985; NRC, 1985; and USDOI, MMS, Herndon, 1992 (Comprehensive Program 1992-1997) and are summarized and incorporated herein by reference. The following biological analyses focus on the effects of routine and accidental activities on phytoplankton, zooplankton, and benthic organisms associated with each alternative. Effects are estimated based on (1) the short-term effect of contact with each activity (seismic surveys, drilling discharges, and construction) or agent (petroleum); and (2) the estimated amount of time exposed to these activities or agents based on the probability of occurrence and contact. Because the effects of these activities or agents are the same for each alternative, they are discussed in depth only in the base-case analysis. The analysis then considers the extent of contact and the probability of occurrence and contact, which varies for each alternative, and thus is the sole basis for differences in the estimated effect of each alternative on lower trophic-level organisms.

(1) **Effects of Seismic Surveys:** During seismic exploration, acoustic-energy pulses are used to locate geological structures that might contain oil or gas. The sources of acoustical energy used in seismic surveys have included explosives and airguns, the latter of which use compressed-air releases to generate sounds.

Seismic surveys are expected to have little or no effect on plankton because the acoustic-energy sources now commonly used in Alaska (airguns), do not appear to have any adverse effect on this group of organisms.

In general, even high explosives have had relatively little effect on marine invertebrates, presumably due to lack of air-containing chambers, such as the swim bladder of fish. Gowanloch and McDougall (1946, cited by Falk and Lawrence, 1973) found no effect of dynamite explosions on shrimp beyond 50 ft and no mortalities at all for oysters. In an experiment by Aplin (1947, cited by Falk and Lawrence, 1973), lobsters 50 ft away from a 90-lb dynamite charge showed no ill effects. Airguns, which are much more innocuous for fish than explosives, also were shown to have no effect on caged oysters placed close to the airgun (Gaidry, unpublished, cited by Falk and Lawrence, 1973).

Although the number and location of seismic surveys for any alternative are unknown at this time, the approximate number can be estimated based on the number of wells and platforms associated with each alternative (see the Exploration and Development Schedule [EDS]). Seismic surveys are typically performed to identify shallow hazards prior to the drilling of exploration/delineation wells and the placement of production platforms. For the base case, the EDS estimates that shallow-hazards seismic surveys would be performed for three exploration wells, five delineation wells, and three production platforms. Based on the lack of apparent effect of seismic surveys on lower trophic-level organisms and this relatively low level of estimated seismic activity, seismic activities associated with the base case are expected to have little or no effect on lower trophic-level organisms.

(2) Effects of Major Drilling and Production Discharges: The types of discharges include drilling muds and cuttings and formation waters. The discharge of drilling muds and cuttings creates plumes of material that disperse rapidly in the water column, becoming diluted by a factor of 10,000 or more within 1 to 4 hours of release, depending on conditions at the time (NRC, 1983). (For additional information, see Sec. IV.B.1.a, Water Quality.) In most continental shelf areas, most drilling muds and cuttings land on the sea bottom within 1,000 m of the discharge point. Environmental factors such as water depth, current speed, tidal exchange, etc., can have large effects on the ultimate fate and dispersion of drilling muds. Drilling muds and cuttings could theoretically affect plankton by reducing primary production, either as a result of reduced light levels or the toxic effect of various compounds in drilling muds. However, the effect of drilling muds on lower trophic-level organisms appears to be restricted to benthic organisms living nearest the discharge source. There is no evidence of effects on plankton from drilling muds (Neff, 1991); in some cases, used drilling muds have been found to enhance primary production (Alldredge et al., 1986).

More than 70 drilling muds have been tested on more than 60 marine species (USDOI, MMS, Alaska OCS Region, 1985). In general, organisms in larval and early juvenile lifestages are more sensitive than adults. Molting crustaceans proved to be more sensitive than intermolt animals (Conklin, Doughtie, and Rao, 1980). During controlled studies, sublethal effects generally have been observed at hydrocarbon concentrations of 10 to 1,000 ppm. Sublethal responses of larvae and adults have included alterations in behavior, chemosensory abilities, feeding, food assimilation, growth, efficiency, skeletal deposition, respiration and nitrogen excretion, and tissue enzyme activity (NRC, 1983). In general, test results suggest that most water-based drilling muds are relatively nontoxic to lower trophic-level organisms. Additionally, the experimental parameters of these tests for both lethal and sublethal effects could not mimic realistic conditions at sea, most notably the rapid dilution and dispersion of drilling muds and cuttings that typically occur in the field. At sea, the effects of drilling-fluid discharges have been limited to areas near and downcurrent of the discharge point, with most effects detected in the benthos. Hence, the effect of muds and cuttings on lower trophic-level organisms associated with the base case (at sea) is expected to be less than that observed during field and laboratory experiments. Results from laboratory and field experiments also suggest that little bioaccumulation of metals from drilling muds occurs in lower trophic-level organisms (NRC, 1983).

In the exploratory phase of the base case, a total of about 2,880 short tons of drilling muds and 3,520 short tons of drill cuttings are expected to be released into the marine environment. These discharges would occur over a 2-year period from 1997 to 1998. During the development and production phase, 48 wells are proposed from three platforms over a 3-year period, with a maximum total release of about 17,760 short tons of drilling muds and 26,880 short tons of drill cuttings (Table II.A.1). Based on studies results, plankton are not expected to be adversely affected by these discharges. Benthic organisms within 1,000 m of the platform are expected to experience mostly sublethal effects with some lethal effects on immature stages. Within this distance, some changes are expected in the species composition of affected benthic areas. However, < 1 percent of the lower trophic habitat within the sale area is estimated to be affected in this way (about 1 km^2). Recovery of the affected benthic communities is expected to occur within 1 year after the drilling discharges cease.

Formation (produced) waters are produced from wells along with oil (see Sec. IV.B.1.a(1)B)2)). Toxic effects on marine plankton and benthos could be produced by the hydrocarbons, metals, or chlorides (brine content) in the formation waters. Discharges of formation waters differ from those of other drilling fluids in that almost all such discharges would occur during development and are likely to be continuous through production. Such discharges should increase in volume as the oil reservoir is depleted. The production of formation waters over the life of the field can be estimated at 18 to 148 MMbbl (see Sec. IV.B.1.a(1)B)2)). Reinjection of formation waters back into the reservoir as an enhanced oil-recovery mechanism would lower the total amount discharged. Complete reinjection would produce no effects on marine life.

Formation-water discharge as a result of the base case likely would produce only small effects. Factors that suggest this are (1) the low toxicity of formation waters (LC_{50} values range from 1,850 to 408,000 ppm; Menzie, 1982); (2) the rapid dilution of these discharges a short distance from the source; and (3) the relatively small area that would be affected by these discharges (1,000-m radius). Acute toxic effects appear to be low (Menzie, 1982). Chronic lethal and sublethal effects may present more of a problem because of the continuous nature of the discharge and the potential for accumulating hydrocarbons in the sediments. Dilutions greater than the toxicity values reported probably would be achieved within several hundred meters of a platform. Assuming a 1,000-m radius for all effects in both the water column and sediments around each of four production platforms, a total of 12 km^2 could be affected.

(3) **Effects of Construction:** This activity involves (1) the placement of a bottom-founded production platform and (2) pipeline laying. This would affect benthic invertebrates and marine plants in the immediate vicinity of these activities. Platforms add a three-dimensional structure to the marine environment and thereby provide additional habitat for invertebrates and marine plants that require a hard, secure substrate for settlement. Less-mobile organisms that rely on soft substrates (e.g., bivalves and polychaetes) would be adversely affected when their habitat is altered or eliminated by platforms or pipeline construction. The more mobile adult invertebrates are expected to avoid these areas of disturbance and are not expected to be affected. Construction associated with this alternative is expected to have little or no effect on phytoplankton or zooplankton communities in the Sale 149 area.

Three production platforms and one pipeline are proposed for this alternative. The placement of the platforms and the pipeline would affect a small area of benthic habitat in the sale area (much less than 1%). Dredging can affect marine organisms by physically altering the benthic environment, increasing sediments suspended in the water column, and killing organisms directly through mechanical actions (Lewbel, 1983). Placement of the platform is expected to kill the immobile benthic organisms under it. Many also will be killed during pipeline laying. Invertebrates and marine plants requiring a hard substrate for settlement are expected to recolonize the area affected by the platform within 1 or 2 years. Hence, the overall effect of the platform would be to alter species diversity in favor of organisms requiring hard substrates over those that do not. Much less than 1 percent of the immobile benthic organisms in the sale area would be affected (mostly sublethal effects) by platform and pipeline construction. The affected benthic communities are expected to recover from these disturbances in <3 years (USDOI, MMS, 1987). Because of the small area affected by the platform and pipeline construction and the widespread distribution of benthic marine organisms in the sale area, the base case is expected to have little effect on lower trophic-level communities in the sale area.

(4) **Effects of Oil:** This section addresses the potential effects of an accidental oil spill on lower trophic-level organisms associated with the base case. The following analysis (1) identifies the expected effect of exposing lower trophic-level organisms to petroleum-based hydrocarbons, (2) factors in the extent of chance of contact and probability of occurrence and contact associated with the base case, and (3) estimates the resulting overall effect on lower trophic-level communities.

(a) **Planktonic Communities:** Phytoplankton are the primary producers of organic material in the ocean and are at the base of the food web. Zooplankton are the secondary producers that feed on phytoplankton and are in turn fed upon by higher food-web species. Hence, it can be seen that any effect on these lower trophic-level organisms (natural or unnatural) is expected to have an effect on higher trophic levels as well.

Some hydrocarbons are produced by phytoplankton naturally, and many have been found to be the same as, or similar to, those found in crude oil (Davenport, 1982). Some hydrocarbons are, therefore, considered a normal part of the chemical makeup of phytoplankton. Hence, hydrocarbons occurring in the water column that are similar to those occurring naturally in phytoplankton are expected to have little effect on phytoplankton. Other petroleum-based hydrocarbons (e.g., chlorinated hydrocarbons) are not of biogenic origin and may have adverse effects on some phytoplankton (USDOI, BLM, Alaska OCS Office, 1976), even at low concentrations.

Because of the difficulties in conducting field studies at sea, much of the information concerning the effects of petroleum-based hydrocarbons on plankton has been obtained from laboratory studies. Because many phytoplankton species are small and delicate and exhibit rapid morphological or physiological changes, most laboratory experiments have been conducted on larger planktonic species that are slower to change. Such experiments typically use unrealistically high hydrocarbon concentrations (Davenport, 1982) in order to elicit a distinct response. Nevertheless, laboratory experiments have provided much useful information, such as the toxic nature of early dispersant agents.

Effects on phytoplankton vary widely depending on the concentration and type of oil or compounds used in the experiments and on the species being tested (NRC, 1985). Nevertheless, general patterns exist, and both laboratory and field studies have shown that hydrocarbons typically inhibit phytoplankton growth at higher concentrations but sometimes enhance growth at lower concentrations. Growth inhibition and/or mortality in phytoplankton has been noted to occur at hydrocarbon concentrations of 1 to 10 ppm. Growth enhancement has been noted at concentrations of 0.1 ppm, or less (NRC, 1985).

In terms of data collected during an oil spill or field study, large-scale adverse effects on plankton have not been reported (NRC, 1985). This may be due in part to the difficulties of conducting such studies (e.g., foul weather, sea state, logistics, and plankton patchiness). Observations of phytoplankton biomass and primary productivity following the *Tsesis* spill (in Sweden in 1977) revealed no significant differences between noncontaminated and contaminated areas (Johansson et al., 1980, as cited in NRC, 1985:442). In cases where studies have been conducted following a spill (e.g., as cited above), this lack of substantial adverse effects on plankton populations due to spilled oil appears common.

Even if it is assumed that a large number of phytoplankton are contacted by an oil spill in an open-ocean area, the regeneration time of the cells (9-12 hours) and the rapid replacement of cells from adjacent waters are expected to preclude any major effect on phytoplankton communities (NRC, 1985). Further, the vertical distribution of most phytoplankton in the water column is typically below the area where it could be adversely affected by hydrocarbons associated with an oil spill. For these reasons, recovery from the effects of the base-case oil spill is expected to take only 1 to 2 days. In areas where flushing rates are reduced (e.g., in bays and estuaries), the concentration of hydrocarbons in the water is expected to be higher. However, the sensitivity of phytoplankton to hydrocarbons may be related to environmental stability (Fisher, 1977) and the history of environmental pollution (Murphy and Belastock, 1980). Hence, plankton from chronically polluted areas (e.g., boat harbors in Kachemak Bay) may be less affected by an oil spill than plankton from the open-water areas in lower Cook Inlet and Shelikof Strait.

The effects of petroleum-based hydrocarbons on zooplankton have been observed in the field at spill sites and also in the laboratory. The primary routes of zooplankton contamination by oil are direct uptake from the water, uptake from food, and direct ingestion of oil particles. It should be noted that some zooplankton have the ability to metabolize and detoxify some types of hydrocarbons, and that this ability varies between species. For example, in scyphozoans and ctenophores, hydrocarbons are discharged unchanged. In crustaceans and ichthyoplankton, they are discharged as metabolites (NRC, 1985). The observed vulnerability of zooplankton to hydrocarbons in the water column (dispersed and dissolved) varies widely. Lethal hydrocarbon concentrations for zooplankton range from about 0.05 to 10 ppm, which is similar to that expected for other small floating organisms (e.g., fish eggs and larvae and crustacean larvae). Sublethal crude-oil concentrations for zooplankton range from about 1 ppm to well below 0.05 ppm (NRC, 1985). Sublethal effects include lowered feeding and reproductive activity, altered metabolic rates, and community changes. Lethality and sublethality are dependent on exposure time, hydrocarbon toxicity, species, and lifestage involved (early stages are most sensitive). For example, substantial sublethal effects would be expected if hydrocarbon concentrations of 0.05 to 0.3 ppm persisted for a week or longer, whereas lethal effects would be expected at 0.5 to 1.0 ppm over the same period of time. However, such concentrations rarely persist in the water column for longer than a few days following a spill and only in small areas (NRC, 1985). (For additional information, see Sec. IV.B.1.a, Water Quality.)

Field observations of zooplankton communities at oil spills and in chronically polluted areas have shown that the communities were affected but that these effects appeared to be short lived (Johansson et al., 1980, as cited in NRC, 1985). Individuals within chronically polluted areas have experienced direct mortality, external contamination by oil, tissue contamination by aromatic constituents, inhibition of feeding, and altered metabolic rates. However, because of their wide distribution, large numbers, rapid rate of regeneration, and high fecundity, zooplankton communities exposed to oil spills or chronic discharges in open-water areas appear to recover (NRC, 1985). In areas where flushing rates and water circulation are reduced (e.g., inner Tutka Bay), the effects of an oil spill are expected to be greater, and recovery of zooplankton biomass and standing stocks are expected to take somewhat longer.

The primary sources of the assumed large (50,000-bbl) oil spill are assumed to be transportation (61% contribution by tankers and pipeline) and one platform spill (39% contributions) (Appendix B, Table B-1). In general, the fate of the oil associated with the large spill would depend on wind speed and duration, air and water temperature, and the composition of the spilled oil. However, based on the assumptions associated with weathering 50,000 bbl of Cook Inlet crude oil within 10 days of the assumed spill during winter, 26 percent of the oil would have evaporated, 46 percent would remain on the surface, and 27 percent would be dispersed into the water column (Table IV.A.3-1).

As indicated above, contact with dispersed and dissolved oil in the water column is of primary concern to phytoplankton and zooplankton. Surface oil and that fraction that evaporates would rarely contact plankton because plankton typically are beneath the surface. The areas most likely to be contacted by a large oil spill would be the sale area and some portions of Shelikof Strait (about 15,084 km^2). If it is assumed that all of the dissolved and dispersed oil from the assumed 50,000-bbl spill is found in the first 5 m of the water column, that the hydrocarbon concentration in this 5-m zone is about 0.1 ppm, and that the surface slick is about 0.8 mm in thickness, a winter spill would cover an estimated discontinuous surface area of 851 km^2 after 10 days (Table IV.A.3-1). Because all of the water under this area (including Shelikof Strait) is phytoplankton and zooplankton habitat, the spill would contact about 5.6 percent of the available plankton habitat in the affected area down to 5 m in depth. Based on the same assumptions, a summer spill (the period when plankton would be most numerous) would cover an estimated discontinuous surface area of 912 km^2 after 10 days, or about 6 percent of the available plankton habitat down to 5 m in depth.

These estimates assume that all plankton under the affected surface areas (5.6% in winter and 6.0% in summer) are inhabiting in the assumed 5-m zone. However, this is unlikely to occur because plankton are typically distributed much deeper than this. More realistically, phytoplankton and zooplankton in the area affected by the assumed oil spill would be found to depths of from 10 to 30 m (depending on water clarity). Hence, in areas where plankton were found to 10-m depths, only 50 percent of their number under the oiled surface area actually would be contacted, or about 3.0 percent (.50 x 6.0) of the area's summer plankton population. In areas where plankton were found to 30-m depths, only 16.7 percent of their number under the oiled area actually would be contacted, or about 1.0 percent (.167 x 6.0) of the area's summer plankton population. This of course assumes that all of the plankton are evenly distributed throughout these depths, and that the concentration of hydrocarbons in the first 5 m of the water column is uniform at 0.1 ppm. However, prior oil-spill measurements have shown that the concentration of hydrocarbons in the water column falls off rapidly just under an oil slick, is not uniform throughout the water column (vertical mixing greatly reduces it), and seldom would be much above background levels below 20 m in depth. Further, phytoplankton and zooplankton typically are very patchy in their horizonal distribution, and in many cases there would be few plankton under an oil slick.

Hence, it can be seen that contact with either 3.0 percent of the area's summer plankton for 10-m depths, or 1.0 percent where they exist down to 30 m, is conservative. More realistically, it is expected that the actual percentage of phytoplankton and zooplankton contacted by the spill (summer or winter) would be less than these percentages. Regarding the actual concentration of oil in the water column from the assumed 50,000-bbl spill, extensive water sampling following the EVOS revealed that hydrocarbon levels in the water column were well below (about 10-1,000 times below) the levels known to be toxic or to cause sublethal effects in plankton and returned to background levels (0.20 ppb) in less than a month (Neff, 1991). However, because the water samples were taken a week or more after the spill, it is unclear what the actual hydrocarbon concentrations were during and immediately following the EVOS. Thus, for purposes of this assessment, hydrocarbon concentrations during and immediately following the base-case spill are conservatively assumed to be initially harmful to phytoplankton and zooplankton (exceeding 0.1 ppm but for <5 days; Meyer, 1990).

The likelihood of plankton populations being adversely affected by a large oil spill (e.g., 50,000 bbl) would be greatest during the spring period when they are most abundant. Assuming that a large spill occurs during this period, about 1 to 3 percent of the plankton in the lower Cook Inlet/Shelikof Strait area is estimated to experience sublethal and/or lethal effects, as explained above. Phytoplankton are expected to recover within 1 or 2 days through regeneration and replacement from adjacent waters, whereas zooplankton recovery may require up to 1 week. However, in areas where water circulation is reduced and flushing times are longer, the number of plankton affected and the time required to recover from these effects may be greater due to longer exposure. These effects also would be exacerbated if attempts were made to remove the oil from oiled intertidal areas. The amount of plankton affected and the recovery time required would depend on the size of the embayment(s), the amount of oil reaching the embayments, hydrocarbon concentration, flushing time, time of the year, and tidal-exchange rate. However, because the OSRA estimates a 1-to 2-percent chance of one or more ≥1,000-bbl spills occurring and contacting many of the embayments in the sale area (e.g., LS's 22-33), it is estimated that another 2 percent of the plankton population in the lower Cook Inlet/Shelikof Strait area may be affected because of extended exposure. This would bring the total estimated percentage of plankton affected to about 5 percent of the total in the affected area. Recovery in the embayment areas is expected to take from 1 to 2 weeks, depending on the specific combination of factors indicated above. Small oil spills (an estimated total of 555 bbl) may adversely affect individual lower trophic-level organisms in areas immediately around the spills. However, they are not expected to have perceptible effects on lower trophic-level organisms at the population level.

(b) Benthic Communities: This section considers the effects of petroleum-based hydrocarbons on marine plants (other than phytoplankton) and invertebrates associated with the base case. Benthic communities are higher in the marine food web than plankton, with some forms feeding on plankton and others feeding at higher trophic levels. Many benthic species are fed upon by higher food-web species such as marine fish, birds, and mammals. Benthic flora also provides shelter for small fish and invertebrates and decreases erosion and turbidity. Hence, any effect on benthic-level organisms (natural or unnatural) would be expected to have an effect on higher trophic levels as well.

In the marine environment, hydrocarbons resulting from an oil spill are broken up by wave action into floating surface oil, dispersed and dissolved oil within the water column, and oil that is incorporated into bottom sediments. Benthic marine plants and animals are affected most by floating surface oil and oil that is being incorporated into bottom sediments through wave action. The most persistent effects occur when the intertidal and shallow subtidal benthic communities are contacted by oil, particularly in areas where water circulation is restricted (e.g., bays, estuaries, and mud flats).

Marine Plants: What is known about the effect of crude oil on marine plants has come largely from observations following oil spills. Both lethal and sublethal effects have been observed. Effects vary considerably depending on plant species, type and concentration of oil, and the timing and duration of exposure. For example, following the *Amoco Cadiz* spill in 1978, much of the intertidal zone along the north Brittany coast was covered by oil for 2 to 3 weeks; however, recovery occurred readily and growth rates appeared normal (NRC, 1985). In contrast, extensive mortality has been observed for some marsh grasses and macroscopic algae, particularly those found in the mid-to-high intertidal area, following oil spills (Teal and Howarth, 1984). While there is considerable variation in the observed effect, some believe that once locally decimated, marine plant species may not reappear for years (5-6 years or more for *Fucus* spp.) (Teal and Howarth, 1984). However, following the EVOS, the recolonization of heavily oiled intertidal rocky habitat began the first year after the spill (Duncan, Hooten, and Highsmith, 1993; van Tamelen and Stekoll, 1993), and complete recovery was expected in 5 to 6 years. Sublethal effects of oil on marine plants include alterations in chlorophyll-a content, photosynthesis, growth, and reproduction. Experiments with several species of macroscopic brown algae have shown that even at very low concentrations, No. 2 fuel oil (0.2 ppb) can affect fertilization, by interfering with the chemical attraction of sperm to eggs (Steele, 1977; Derenbach and Gerek, 1980).

Observations and measurements of *Fucus* species and other closely related genera further illustrate the typical variation that exists in the effect of oil on marine plants. After the *Tsesis* spill (in Sweden in 1977), the predominant littoral plant (*Fucus vesiculosus*) was not measurably affected. In contrast, following the *Arrow* spill, the vertical distribution of *F. vesiculosus* was reduced for 5 years. After the *Amoco Cadiz* spill in 1978, the fucoid *Ascophyllum* sp. was killed and replaced by *Fucus* sp. (Teal and Howarth, 1984). *Fucus distichus*, an Alaskan species, showed little effect when exposed to 7 ppm Prudhoe Bay crude oil for 2 to 4 hours (Shiels, Goering, and Hood, 1973). Another common marine plant in the lower Cook Inlet area is eelgrass *(Zostera marina)*, which occurs in more protected marine environments such as bays and lagoons. Large spills of both crude and fuel oil are reported to have had little effect on eelgrass, aside from the loss of some leaves (Thomas, 1973; den Hartog and Jacobs, 1980). Following the EVOS, eelgrass shoot and flower densities were reported to be lower at oiled sites for up to 2 years (Dean, Stekoll, and Jewett, 1993). However, others believe that eelgrass-shoot density was more related to site disturbances due to shoreline treatment than to oil contamination (Lees et al., 1991; Houghton et al., 1993). Observations like these have shown that while intertidal and shallow subtidal marine plants are often adversely affected by oil, they are not always affected in a substantial way. Further, in the areas that were substantially affected by oil, recovery to prespill conditions is likely to occur within 3 years (longer if hot-water washed).

The estimated effect of the assumed oil spill on marine plants in the lower Cook Inlet area would depend on the type and amount of oil reaching the intertidal and shallow subtidal zones, where marine plants are most abundant. The type of oil reaching the intertidal and shallow subtidal zones would be mostly floating oil. Some of this would be dispersed into the water column by wave action as it reaches the shoreline. Within 10 days of the assumed spill, about 26 percent of the oil would have evaporated, 46 percent would remain on the surface, and 27 percent would be dispersed into the water column (Table IV.A.3-1). However, because the movement of dispersed oil in the water column primarily depends on water currents as it moves away from the spill point, most dispersed oil will remain in the water column offshore and is not expected to reach the shore. In general, the longer it takes spilled oil to reach the shore, the less oil is expected to arrive there.

The amount of floating oil expected to reach marine-plant habitat also depends on the amount spilled, location of the spill, and water/wind conditions following the spill. In this analysis, the oil spill of 50,000 bbl is assumed to occur in the summer, the most biologically productive period of the year. The OSRA estimates only a 1- to 2-percent combined probability of one or more spills ≥1,000 bbl occurring and contacting LS's 21 through 35, 40, and 42 within 10 days (much of western Cook Inlet and some of western Shelikof Strait) (Appendix B, Table B-14). For purposes of assessment, it is assumed here that much of Cook Inlet and some of Shelikof Strait is contacted by the spill. However, due to the amount of time elapsed in reaching the shore (10 days), the more toxic hydrocarbon fractions would have evaporated and are not expected to affect marine plants onshore.

Based on these assumptions and estimated points of contact, oil associated with the base-case spill is estimated to contact about 50 percent of the intertidal and shallow subtidal habitat within the lower Cook Inlet area (i.e., 50% of the land segments). It is further estimated that of this 50 percent, about 40 to 60 percent of the marine plants contacted would be either killed or sublethally affected (reduced photosynthetic, reproductive, or growth activity). This represents 20 (.50 x 40) to 30 (.50 x 60) percent of the intertidal and shallow subtidal marine plants in the lower Cook Inlet/Shelikof Strait area. In general, the percentage killed would be greatest nearer the spill point, with sublethal effects predominating as the oil moves farther away. In areas where the oil persists, such as in restricted bays, marine plants sublethally affected by oil eventually may die. The floating reproductive stages of marine plants (spores and gametes) are more susceptible to the toxic effects of oiling than adults. However, toxic hydrocarbon levels are likely to occur only near the spill site and are estimated to affect <1 percent of the spores and gametes in the sale area.

Because of the elimination of some predatory intertidal herbivores, some intertidal areas may exhibit a short-term proliferation of certain algal species (e.g., *Ulva sp.*), giving oiled marine plants a green color and the appearance of rapid recovery (NRC, 1985). Recovery of heavily damaged vegetation is expected to begin as spores and gametes are brought into the area from other lower Cook Inlet plant communities and from the Alaskan Coastal Current, which support similar marine-plant species. The recovery time would vary depending on the amount and type of oil involved, the type of habitat affected, and the rate of flushing. In general, most high-energy rocky habitats are expected to recover in about 2 to 3 years (Dean, Stekoll, and Jewett, 1993; van Tamelen and Stekoll, 1993; and Houghton et al., 1993). In lower energy habitats (e.g., restricted bays) or in any area where oil persists, recovery may take up to 7 years, depending on how long oil continues to contaminate marine-plant communities. Small oil spills (an estimated total of 555 bbl) may adversely affect individual lower trophic-level organisms in small areas immediately around the spills. However, they are not expected to have perceptible effects on lower trophic-level organisms at the population level.

Marine Invertebrates: Dominant marine benthic invertebrates in the Cook Inlet/Shelikof Strait area include mollusks (clams and mussels), annelids (polychaete worms), crustaceans (crab and shrimp), and echinoderms (sand dollars and sea urchins). Crude oil can have lethal effects on marine invertebrates due to either a short-term exposure to high hydrocarbon concentrations or a long-term exposure to lower hydrocarbon concentrations. Lethal effects also can occur from the smothering effect of heavy oils, particularly in the less mobile and exposed benthic forms. In addition to these variables, the effect of hydrocarbons on marine invertebrates also varies in relationship to the species and the lifestages involved (NRC, 1985).

Sublethal effects on crustaceans can include failure to molt or swim, bioaccumulation, reduced growth, and inhibition of feeding and/or reproduction (typically the result of reduced chemoreceptive abilities). Adult king crabs would be most vulnerable to the effects of an oil spill when they move into more shallow coastal waters in the spring and summer to molt and mate. Crustaceans are particularly sensitive to oil just before and following molting, and crabs must molt before mating. So vulnerability is increased due to location, season, and physiological condition of the crabs. Molting is related to growth, so larvae, which molt more frequently than adults (Caldwell, Calderone, and Mallon, 1977), are more susceptible to the effects of spilled oil. Immature crab and their pelagic larvae are susceptible to surface and dissolved oil and also to oil that becomes entrained in intertidal sediments and is later released back into the water column.

Laboratory studies indicate that oil concentrations ranging from 1 to 4 ppm can be lethal to both adult and larval crab and shrimp after 96 hours of exposure (Starr, Kuwanda, and Trasky, 1981). Larval shrimp and crabs take up hydrocarbons very rapidly with effects also appearing rapidly. Larvae in lethal concentrations of hydrocarbons stop swimming in <20 minutes, which, if it occurred in the natural environment, probably would result in death (Rice et al., 1983). Juvenile king crab exposed to sublethal levels (<6 ppm) of the water-soluble fraction of Cook Inlet crude oil showed little change in respiration. But when exposed to levels that would cause death within 96 hours, their respiration quickly declined (Rice et al., 1976). King crab also accumulated soluble aromatic fractions in gill, muscle, and gut tissue. Larval development may be affected by exposure to crude oil, but king crab eggs seemed more resistant. Tanner crabs exposed to 560 ppm of Prudhoe Bay crude experienced a 26-percent mortality rate, and those surviving lost an average of 3.3 legs per crab (Karinen and Rice, 1974). A 48-hour exposure of tanner crabs to 1,000 ppm of crude oil 1 to 4 weeks prior to molting reduced the proportion of successful molts later.

Other predominant intertidal invertebrates in the lower Cook Inlet/Shelikof Strait area (e.g., bivalves, polychaete worms, sea urchins, limpets, and barnacles) also are expected to be adversely affected by an oil spill. Oil has been shown to interfere with chemoreception, which is used by many invertebrates to find their prey (Brown, Baissac, and Leon, 1974), as well as to affect larvae and reproduction (Lonning and Hagstrom, 1975; Armstrong et al., 1983). Large oil spills often have resulted in mortality of bivalves (Teal and Howarth, 1984), which are fed on by many species of marine birds, fish, and mammals. Effects on bivalves can be almost immediate, but declines in numbers may continue for years (6 years—Thomas, 1976). These delayed declines may be brought about by the delayed release of oil from intertidal bottom sediments and a subsequent uptake and accumulation of hydrocarbons, reduced settlement into contaminated sediments, decrease in gonadal development and fecundity, and increased predation due to alteration of behavior.

Studies following the EVOS in 1989 showed that significant hydrocarbon concentrations in intertidal sediments were found at heavily oiled sites, followed by an apparent migration of the oil into the shallow subtidal zone in 1991 (Wolfe et al., 1993). Significant concentrations of oil were not found in the subtidal zone. Hence, except for floating larval forms close to the surface, most lower trophic-level organisms inhabiting subtidal areas are not expected to be contacted by oil from an oil spill. This includes most adult crab and shrimp, because they typically inhabit the deeper subtidal areas. However, in areas where intertidal beach sediments are heavily contaminated, hydrocarbons eventually may move into subtidal areas and be taken up by some marine invertebrates. Events of this type are estimated to have sublethal effects on <5 percent of the subtidal benthic populations in the lower Cook Inlet/Shelikof Strait area. Regarding the toxicity of intertidal areas contaminated by the EVOS, Gilfillan et al. (1993) have shown that the toxicity of oiled intertidal sediments declined rapidly after the spill. Within 18 months, about 75 percent of the oiled shoreline had recovered. In fact, toxicological results indicate that the oiled shoreline was at toxic hydrocarbon levels for only a few months to 1 year. The remaining hydrocarbons were found to be generally nontoxic and are thought to serve as a food source for biota (e.g., bacteria).

Marine larvae and eggs floating close to the surface are likely to be contacted by either surface or dissolved oil from an oil spill, particularly from spring to fall when they are most abundant. Marine invertebrates inhabiting the intertidal zone (e.g. clams, mussels, worms, juvenile crab, barnacles, limpets, and echinoderms) also are likely to be contacted by an oil spill, particularly where eelgrass beds have been oiled (they tend to retain the oil). Because of the tendency of rocky habitats to support increased species diversity over that of sandy habitats, oil contacting rocky habitats (e.g., the eastern side of lower Cook Inlet and Shelikof Strait) is expected to affect a greater number of species. However, rocky intertidal areas are often unprotected and are quicker to recover from the effects of an oil spill due to higher rates of flushing. Protected intertidal areas (e.g., bays and mud flats) are expected to require longer to recover from the effects of an oil spill because of the reduced rate of flushing and the tendency for oil to accumulate and settle in the sediments of such areas.

The effect of oil on intertidal areas is expected to be greater if the oil contacting the shore is relatively fresh (unweathered) or is a refined fuel oil. Such oils are more toxic and are expected to result in a greater percentage of mortality on contact. Studies following the EVOS have shown that the recovery of lower trophic-level organisms requires longer when shorelines were cleaned (due to burial, displacement, reductions in fines, and organic content) than areas that were heavily oiled but not treated (van Tamelen and Stekoll, 1993; Lees et al., 1991; Houghton et al., 1993). Three years following the spill, there were few differences between intertidal communities that were oiled and those that were not oiled. However, in areas that were hot-water washed (particularly the upper intertidal zone), infaunal communities are expected to take many more years to recover. In fact, some hard-shelled clam species in Prince William Sound are estimated to take another 10 years to recover because of disturbances associated with shoreline treatment (Houghton et al., 1993). Hence, attempts to clean oil from intertidal areas are expected to exacerbate any adverse effects on lower trophic-level organisms.

The estimated effect of the assumed oil spill would depend on the species and lifestages contacted as well as the type and amount of oil reaching the intertidal and shallow subtidal zones, where contact with marine invertebrates is most probable. The type of oil reaching the intertidal and shallow subtidal zones would be mostly floating and dispersed oil. Some of this oil would be dispersed into the water column by wave action as it reaches the shoreline and would be incorporated into bottom sediments. The assumed oil spill of 50,000 bbl is assumed to occur in the summer, the most biologically productive period of the year. The OSRA estimates only a 1- to 2-percent combined probability of one or more spills ≥1,000 bbl occurring and contacting LS's 21-35, 40, and 42 within 10 days (much of western Cook Inlet and some of western Shelikof Strait) (Appendix B, Table B-14). For purposes of assessment, it is assumed here that much of Cook Inlet and some of the Shelikof Strait would be contacted by the spill. However, due to the amount of time elapsed in reaching the shore (10 days), the more toxic hydrocarbon fractions would have evaporated and are not expected to affect marine plants onshore.

Based on these assumptions and estimated points of contact, oil associated with the base-case spill is estimated to contact about 50 percent of the intertidal and shallow subtidal habitat (rocky and sandy) within the Cook Inlet and Shelikof Strait area (i.e., 50% of the land segments). It is further estimated that of this 50 percent, about 40 to 60 percent of the marine invertebrates contacted would either be killed or would be sublethally affected (e.g., failure to molt or swim; reduced growth, feeding, and/or reproduction). This represents 20 (.50 x 40) to 30 (.50 x 60) percent of the intertidal and shallow subtidal marine invertebrates in the lower Cook Inlet/Shelikof Strait area.

Those most likely to be contacted in the intertidal and shallow subtidal area include clams, mussels, polychaete worms, juvenile crab, limpets, barnacles, sea urchins, and snails. Lethal effects are expected to occur where hydrocarbon toxicities exceed the tolerance of individual organisms and also when heavy oil (or emulsions thereof) smothers marine invertebrates. The percentage of invertebrates killed would be greatest nearer the spill point, with sublethal effects predominating as the oil moves farther away. More mobile forms (e.g., crab) are expected to be less affected than attached or less mobile forms. These effects would be exacerbated if attempts were made to remove the oil from oiled intertidal areas. While the floating reproductive stages of marine invertebrates (eggs and larvae) are more susceptible than adults, toxic hydrocarbon levels are likely to occur only near the spill site and are estimated to affect <1 percent of the eggs and larvae in the sale area.

The recovery time of the affected communities would vary depending on the amount and type of oil involved, the type of habitat affected, and the rate of flushing. In general, most high-energy rocky habitats are expected to recover in about 2 to 3 years. In lower energy habitats (e.g., restricted bays) or in any area where oil persists (e.g., oil trapped in bottom sediments), benthic marine invertebrates sublethally affected by oil either may be killed or continue hydrocarbon uptake long after the initial spill (Rounds et al., 1993). Recovery in these areas (particularly infaunal habitats) may take up to 7 years, depending on how long the trapped oil continues to contaminate these lower energy habitats. Small oil spills (an estimated total of 555 bbl) may adversely affect individual lower trophic-level organisms in small areas immediately around the spills. However, they are not expected to have perceptible effects on lower trophic-level organisms at the population level.

<u>**Summary:**</u> The base case could affect lower trophic-level communities (phytoplankton, zooplankton, and benthic) by exposing them to petroleum-based hydrocarbons, seismic surveys, the discharge of drilling muds, and construction activities. Because lower trophic-level organisms are at the lower end of the food web and supply much of the food for higher level organisms, any effect on them (natural or unnatural) is expected to affect higher level organisms as well.

Because of the prevalent use of airguns in Alaskan OCS waters and the apparent lack of effect on plankton and benthic organisms, seismic surveys are expected to have little or no effect on lower trophic-level organisms. Drilling discharges are estimated to affect <1 percent of the benthic organisms in the sale area. Affected benthic organisms are expected to experience mostly sublethal effects, but some would be killed. Recovery is expected to occur within 1 year after the discharges cease. Dredging and construction are expected to have little or no effect on plankton communities. Less than 1 percent of the immobile benthic organisms would be affected (mostly sublethal effects). Benthic invertebrates and plants needing a hard substrate for settlement are expected to colonize the platform within 1 or 2 years. Immobile benthic communities affected by pipeline construction are expected to recover in <3 years.

The effect of petroleum-based hydrocarbons on phytoplankton, zooplankton, and benthic organisms depends on the species and lifestage, the type and concentration of hydrocarbon, and the duration of exposure. The potential effects of such exposure range from sublethal to lethal. Larval forms are more sensitive to toxic agents than adults and would sustain the greatest adverse effect from spring to fall when they are most abundant. These effects would be exacerbated if attempts are made to remove the oil from oiled intertidal areas. Where flushing times are longer and water circulation is reduced (e.g., bays, estuaries, and mudflats), adverse effects are expected to be greater, and the recovery of the affected communities is expected to take longer.

The adverse effects of oil on phytoplankton include inhibition of photosynthetic activity and growth, lowered feeding and reproductive activity, community changes, and death. Assuming that a large number of phytoplankton were contacted by an oil spill, the rapid replacement of cells from adjacent waters and their rapid regeneration time (9-12 hours) would preclude any major effect on phytoplankton communities. Zooplankton can be contaminated by oil by direct uptake from the water, uptake from food, and direct ingestion of oil particles. Observations in oiled environments have shown that zooplankton communities experienced short-lived effects due to oil, although individual organisms experienced either direct mortality, external contamination, tissue contamination by aromatic constituents, inhibition of feeding, or altered metabolic rates. Affected communities appear to rapidly recover from such effects because of their wide distribution, large numbers, rapid rate of regeneration, and high fecundity. Large-scale effects on plankton due to petroleum-based hydrocarbons have not been reported to date.

Based on the assumptions discussed in the text, the assumed base-case oil spill is estimated to have sublethal and lethal effects on 1 to 3 percent of the phytoplankton and zooplankton populations in the lower Cook Inlet area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. The total percentage of plankton affected could increase to 5 percent if many embayments were contacted by the spill. Recovery within the affected embayments is expected to take 1 to 2 weeks.

The sublethal effects of oil on marine plants include reduced growth and photosynthetic and reproductive activity. The sublethal effects of oil on marine invertebrates include adverse effects on reproduction, recruitment, physiology, growth, development, and behavior (feeding, mating, and habitat selection). Marine plants and invertebrates in subtidal areas are not likely to be contacted by an oil spill, except for floating larval forms, which may be contacted anywhere near the surface. Marine plants and invertebrates in intertidal and shallow subtidal areas are likely to be contacted by an oil spill. Attempts to clean oiled habitats are expected to exacerbate adverse effects and increase recovery time.

Based on the assumptions discussed in the text, the assumed base-case oil spill is estimated to have lethal and sublethal effects on about 20 to 30 percent of the intertidal and shallow subtidal marine plants and invertebrates in the lower Cook Inlet/Shelikof Strait area. Recovery of these communities is expected to take 2 to 3 years in high-energy habitats and up to 7 years in lower energy habitats.

<u>**Conclusion:**</u> The assumed 50,000-bbl-oil spill is estimated to have lethal and sublethal effects on 1 to 3 percent of the phytoplankton and zooplankton populations in the open-water areas of the lower Cook Inlet area. Recovery in

open-water areas is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. Another 2 percent of the area's plankton population may be affected because of embayments being contacted, bringing the total up to 5 percent. Recovery in embayment areas is expected to take 1 to 2 weeks.

The assumed base-case oil spill also is estimated to have lethal and sublethal effects on about 20 to 30 percent of the intertidal and shallow subtidal marine invertebrates in the lower Cook Inlet area. Recovery of these communities is expected to take 2 to 3 years in high-energy habitats and up to 7 years in lower energy habitats. Less than 5 percent of the subtidal benthic populations in the lower Cook Inlet area are expected to be affected.

c. **Effects on Fisheries Resources:** Fisheries resources (pelagic, demersal, and semidemersal fishes) in the lower Cook Inlet are described in Section III.B.2. Routine activities associated with this alternative that may affect fisheries resources include drilling discharges, offshore construction activities, and seismic surveys. Accidental activities that may affect fisheries resources include exposure to spilled oil. As outlined in the general discussion for this section, oil in marine waters dilutes rapidly. During the course of this project, one large oil spill ≥1,000 and 49 smaller oil spills of 1 to 999 bbl are assumed to occur. For the purposes of analysis, this EIS assumes one 50,000-bbl spill will occur (Table IV.A.2-2). In summer, a 50,000-bbl-oil spill in lower Cook Inlet would discontinuously influence 190 km^2 after 3 days, 912 km^2 after 10 days, and 3,715 km^2 after 30 days (Table IV.A.3-1). During winter, the discontinuous distribution of a 50,000-bbl-oil spill would be reduced to 178 km^2 after 3 days, 851 km^2 after 10 days, and 3,458 km^2 after 30 days (Table IV.A.3-1).

To help estimate the potential effects of an oil spill for proposed Sale 149, an OSRA was performed for the lower Cook Inlet area. (Readers interested in more detail on the model and the assumptions used are directed to Sec. IV.A.2.a.) The following section describes the potential effects of oil contact to fisheries resources in the sale area using the OSRA-model results.

Combined Probabilities: The combined probabilities estimate the probability of a spill occurring from all sources (transportation or platform) and contacting environmental resource areas (ERA's), land segments, and sea segments during the 19-year life of the proposal at intervals of 3, 10, and 30 days. The names and locations of environmental resource areas and land and sea segments referred to throughout this section are listed in Table IV.A.2-1.

The relatively low probability of oil occurrence and contact to various environmental resources is illustrated by examination of the highest probabilities. After 3 days, the combined probabilities (expressed as percent chance) for one or more ≥1,000-bbl spills occurring and contacting Tuxedni Bay (ERA 1) is 6 percent, and for outer Kamishak Bay (ERA 4) is 6 percent. After 10 days, the combined probability increases to 8 percent for outer Kamishak Bay (ERA 4) and to 7 percent for Tuxedni Bay (ERA 1). After 30 days, the combined probability of one or more ≥1,000-bbl spills occurring and contacting outer Kamishak Bay or Tuxedni Bay does not change. Fish species from these resource areas potentially affected by oil spills are returning adult salmon (king, red, pink, chum, and silver), steelhead trout, and eulachon transiting lower Cook Inlet; outmigrating juvenile salmon entering Cook Inlet from natal rivers and streams; herring, true cod, and halibut; and walleye pollock in the vicinity of Cape Douglas. For all other environmental resource areas and land segments, estimated combined probabilities (expressed as percent chance) of one or more spills ≥1,000 bbl occurring and contacting are <5 percent.

(1) **Effects of Oil Spills on Fisheries Resources:** There are at least five possible ways oil can affect fish populations: (1) eggs and larvae can die or suffer increased mortality in spawning or nursery areas due to coating or direct toxic effects; (2) adults can die or fail to reach spawning grounds in critical, narrow, or shallow contaminated waterways; (3) fecundity or spawning behavior may be changed; (4) local food species of the adults, juveniles, fry, or larvae may be adversely affected or eliminated; and (5) sublethal effects may reduce fitness and affect the ability to endure environmental perturbations. However, concentrations of petroleum hydrocarbons (PHC's) are toxic to pelagic fishes only a short distance from and a short time after a spill event (Malins, 1977; Kinney, Button, and Schell, 1969). Concentrations of PHC's beneath the initial surface slick are <0.1 ppm, well below toxic levels for finfishes (Malins, 1977).

(a) **Pelagic Fishes:** Some pelagic fishes (salmon) are able to detect and avoid hydrocarbons in the water (Weber, 1988), though some salmon may not completely avoid oiled areas and may become temporarily disoriented, but they would eventually return to their home stream (Martin, 1992). The summer season is when many migratory fishes would be most abundant in the Sale 149 area. Adult salmon remain relatively unaffected by oil spills and are able to return to natal streams and hatcheries even under very large oil-spill conditions, as evidenced by pink and red salmon returning to Prince William Sound (PWS) and red salmon returning to Cook Inlet after the *Exxon Valdez* oil spill (EVOS). When oil from the EVOS entered Cook Inlet in 1989, the Alaska Department of Fish and Game closed the sockeye salmon commercial fishery in Cook Inlet. This apparently resulted in overescapement of spawning fish in the Kenai River system for the third consecutive year. Overescapement in 1987 was due to a previous spill, and in 1988 there was a naturally high escapement. As a result of the cumulative overescapements, fisheries managers observed what appeared to be a decline in salmon smolt production. Although the reason for the apparent decline in smolt production is uncertain, it is thought to be the result of overescapement and too many salmon fry to be supported by the available food supply. The extent of the decline was speculative. Managers were originally predicting that adult salmon returns in 1994 and 1995 would be below escapement goals, but the 1994 returns were three times what was forecast. Figures for 1995 are not available at this time, but escapement goals were met and commercial fisheries were operating. Overescapement in a single year likely would not be a problem.

Eggs of pelagic fishes that spawn upstream in rivers and streams also would be unaffected by an oil spill. However, pink salmon (often intertidal spawners) egg mortality was higher in some oiled intertidal areas than in unoiled areas from 1989 to 1992, but these differences were not maintained in egg-to-fry survival (Bue et al., 1993). Although no significant difference in egg-to-fry survival between oiled and control streams was observed, the author believed this likely was due to insufficient power in the sampling design or sampling levels rather than a true lack of change. Other studies examining egg and fry survival showed no difference between oiled and unoiled locations (Brannon et al., 1993) except in two cases—one that showed higher mortality at an unoiled stream and another that showed higher mortality at the high-tide station of an oiled stream. There currently is some thought that pink salmon eggs may have suffered some genetic damage, but whether this has happened and to what extent is unknown. The FEIS for the EVOS Oil Spill Restoration Plan states: "it is estimated that the runs of pink salmon in Prince William Sound in 1991 and 1992 were reduced by less than 2 percent to as much as 10 percent because of genetic damage that caused egg mortality and because of other environmental factors." In any event, small differences in egg mortality probably have little biological meaning with species that spawn thousands of eggs and suffer a natural mortality of over 90 percent. In fact, the 1989 brood year returned to PWS in very high numbers in 1991, reflecting little apparent effect of the spill on egg-to-adult survival.

An oil spill in the vicinity of outer Kamishak Bay (ERA 4) or Tuxedni Bay (ERA 1) is not expected to directly affect returning adult salmon or steelhead. Oiled intertidal areas may cause an increased mortality to pink salmon eggs in the affected areas, but the increased egg mortality is not expected to be enough to cause reduced survival to adulthood.

Adult herring returning to spawn in PWS in 1989 were relatively unaffected by the spill and were successful in leaving one of the largest egg depositions since the early 1970's. Total herring-spawn length for 1989 was 158 km, with 96 percent in unoiled areas, 3 percent in areas of light to very light oiling, and only 1 percent in areas characterized as moderate to heavy oiling (Pearson, Mokness, and Skalski, 1993). Other researchers estimated that over 40 percent of the areas used by the Prince William Sound stocks for spawning and over 90 percent of the nearshore nursery areas were exposed to spilled crude oil (Biggs and Baker, 1993).

However, several studies examining egg/larval development and survival indicate some problems associated with herring spawned in oiled areas. Herring-larvae malformations, as measured by severity of malformation and percentage of malformed larvae, ranked consistently with degree of oiling (Hose, Biggs, and Baker, 1993). Early developmental stages of herring embryos (24-48 hr) were most sensitive to Prudhoe Bay crude, as measured by increased mortality. Also, increased concentrations of the water-soluble fraction resulted in increased malformations (Kocan, Hose, and Biggs, 1993). Herring-egg-larval mortality may have been higher in oiled areas of PWS, but data were inconclusive due to between-site variability (McGurk and Biggs, 1993). None of these studies were able to determine whether the observed differences reduced recruitment to the herring population; but analysis of the large 1992 herring catch indicated a lower than expected contribution of 1989 year-class herring to the population (Funk, Carlile, and Baker, 1993). It is possible that the increased level of developmental malformations and increased egg-larval mortality, along with environmental effects, may have contributed to the smaller herring runs in PWS during 1993 and 1994.

(b) **Semidemersal Fishes:** Pollock, sablefish, Pacific cod, eulachon, and a number of other regional finfishes tend to inhabit midwaters at times. These changes in depth may be in response to factors such as light conditions and foraging activities. There is no precise depth range for semidemersal fish species; hence, the assumption for purposes of analysis is depths of 50 m, or more. Classification for effects analysis also is confounded by some semidemersal species having pelagic or benthic eggs/larvae. These assumptions apply only to deepwaters.

In summer, a 50,000-bbl-oil spill would discontinuously contact 3,715 km^2 after 30 days (Table IV.A.3-1), but the remaining oil presumably would be weathered and evaporated to where it would no longer be toxic to semidemersal fishes, even if some small volumes were to reach bathypelagic depths (Kinney, Button, and Schell, 1969). Pollock sampled from PWS and Tugidak Island in 1990 following the EVOS showed evidence of fluorescent aromatic compounds (FAC's), but these dropped substantially in 1991 (Collier et al., 1993). Some proportion of the pelagic eggs or larvae of semidemersal fish possibly could be contaminated and their viability reduced. Also, eulachon are anadromous and could be oiled when returning to their natal streams to spawn. But as with adult salmon, they would not suffer population-level effects. The resource areas contacted as discerned by combined probabilities represent only a fraction of a percent of the available semidemersal fish habitat in the lower Cook Inlet region; hence, even if fish, eggs, or larvae are contacted, it is unlikely that any large part of these populations would be affected.

(c) **Demersal Fishes:** Pacific halibut, a number of other flatfishes, and rockfishes are the principal demersal fishes in lower Cook Inlet. They inhabit near-bottom areas over most of the Sale 149 area. Oil contacting demersal fishes and/or their environment could expose these species to toxic effects ranging from sublethal to lethal. The magnitude of these effects depends on environmental factors that influence the concentration and distribution of oil in marine waters. As mentioned above, concentrations of PHC's beneath the initial surface slick are <0.1 ppm, well below toxic levels for finfishes. Thus, the exposure of demersal fishes to oil would be minimal.

Following the EVOS, several demersal fish species were examined for the presence of FAC's to estimate exposure to oil (Collier et al., 1993). Also, yellowfin, rock, and flathead sole were examined for lesions in various organs; no lesions were found. There were increased levels of FAC's for all three species of sole and increased respiratory epithelial hyperplasia of the gill for rock sole at three oiled sites. Pacific halibut sampled at >30 m showed even lower levels of FAC's in 1989, and the levels decreased substantially in 1990. Though FAC's were measurable in demersal fishes, there was no indication of profound population-level effects to any of these species (Collier et al., 1993).

Rockfish (yelloweye, quillback, and copper) examined for histopathological lesions and elevated levels of hydrocarbons in their bile indicated significant differences between oiled and control locations (Hoffman, Hepler, and Hansen, 1993). Additionally, at least five rockfish examined were killed by exposure to oil. While no population-level effect was noted in these species, these data indicate spilled oil reached and exposed demersal fishes to both sublethal and lethal toxic effects.

Thus, demersal fish populations could be exposed to oil in the event of a spill, and some individuals could be killed. Further, some egg and larval mortality also could occur. Based on the experience of the EVOS, however, it is unlikely there would be any population-level effects to demersal fishes.

(2) **Indirect Effects of Oil Spills on Fisheries Resources:** Some examples of indirect effects of oil spills on fisheries resources are reduced food resources, genetic effects potentially causing sterility, and increased stress to fish populations making them more susceptible to disease.

There is speculation that decreased pink salmon returns to PWS in 1993 may be due to a genetic effect on eggs incubated in oil-contaminated gravel in 1989. This may have caused functional sterility in the returning adults in 1991, which returned in record numbers. There is no direct evidence to support this, and one study (Brannon et al., 1993) examining chronic oil-exposure effects to gametes taken from spawners on oiled and unoiled streams revealed no gametogenic effects (i.e., reduced fertility or gamete inviability). Complicating the picture, pink returns were very low in 1992 as well as in 1993 and, in both years, returns were low for both hatchery and wild fish. Thus, functional sterility cannot be invoked for the low return of 1992 fish, and there is no similar explanation for the low return to hatcheries in both years. It is more likely that the low returns are related to environmental effects (temperature, food availability, etc.) contributing to poor at-sea survival.

It was suggested that the EVOS caused a reduction in food available to herring and pink salmon populations in PWS, and this has caused reduced survival and subsequent failures in pink salmon runs and herring catches in 1992 and 1993 and the 1994 herring catch. Studies examining the growth, survival, and availability of prey for juvenile pink salmon have been conflicting.

Growth rates of Armin F. Koernig-hatchery pink salmon were significantly lower in lightly oiled areas versus moderately oiled areas in 1989, but there was no difference around the same areas in 1990 (Willette, 1993). There was a significant difference again in 1991 but of half the magnitude of 1989. There was no significant difference in growth of Wally H. Norenberg-hatchery pinks in moderately versus unoiled areas in 1989 to 1991 (Willette, 1993).

Another study examined juvenile pink and chum salmon contaminated by ingesting EVOS crude in 1989 (Wertheimer et al., 1993). Oil was present in 1 percent and 3 percent of these salmon collected at oiled sites in 1989, but there was no evidence of oil contamination in these same areas in 1990. Juvenile salmon were more abundant in unoiled areas, and this difference held even in 1990 when oil-exposure levels diminished. Thus, the observed difference was attributed to geographic differences in production and migration rather than oil exposure. Further, the diet composition and feeding efficiency of these fish was unaffected by the oil spill. In 1989, consumption of epibenthic prey was greater in nonoiled areas with zooplankton greater in oiled areas, with the situation reversed in 1990. The difference was attributed to the timing and abundance of the spring zooplankton bloom. However, juvenile pinks were smaller and slower growing in oiled areas in 1989 but not 1990, and the condition factor was higher in oiled areas for both years. Juvenile chum were larger in oiled locations in both years, with no difference in condition factor between oiled and unoiled locations. There was no evidence of a reduction in available prey to pinks and chums in oiled areas in 1989 or 1990. The slower growth of pink juveniles in 1989 was attributed to the metabolic cost of depurating the hydrocarbon burden (Wertheimer et al., 1993; Carls et al., 1993); and the slower growth of juvenile pinks may have caused an incremental reduction in survival to adulthood.

Some suggest that herring population in PWS may be showing signs of stress, and this could be due to lingering effects of the EVOS. In 1993, there was a high rate of viral infection (viral hemorrhaghic septicemia [VHS]) in the PWS herring population, and many fish had lesions. It is unknown whether the VHS is linked to the occurrence of the lesions, and there are no data connecting the outbreak of the lesions to the EVOS 5 years previous. It is possible that stress to the herring population as a result of the oil spill may have made the population more susceptible to VHS and to the fungus that has been found in the population. Herring populations historically fluctuate, and environmental factors and natural variability also should be considered as possible causes of the lesion outbreak and the poor herring returns.

(3) Effects of Drilling Discharges on Fisheries Resources: As discussed in Section III, drilling discharges affect very small areas of the benthos, and their fluid components are diluted rapidly by marine waters (Dames and Moore, 1978). The estimated mass/volume of this discharged material probably would have no effect on pelagic or semidemersal fishes inhabiting the waters of the sale area. The area affected over time is too limited to have adverse effects. However, in some operations the discharge points are benthic. If demersal fishes are present at the time of discharge, it is probable that they would be disturbed and displaced from the immediate vicinity of the discharge, within a radius probably not to exceed 100 m. This is variable to some degree on factors such as water depth and currents. These effects on demersal fishes very likely would be limited to only the short time periods when materials are being discharged.

(4) Effects of Offshore Construction on Fisheries Resources: During offshore drilling and after discovery, construction of permanent facilities, including pipelines, may be required. The base case includes three platforms and 125 pipeline miles.

Fishes inhabiting or transiting lower Cook Inlet could be subjected to offshore/onshore construction activities from the base-case. These activities could cause disturbance to pelagic fish and displacement from their preferred habitat, as turbidity from this work is increased. Positive effects may accrue as offshore structures attract and protect some species. Any disturbance or displacement should be short term (hours to days), limited to only the time of construction and shortly thereafter.

(5) **Effects of Seismic Surveys on Fisheries Resources**: Seismic surveys, probably using airguns, would be used during oil exploration in the proposed sale area. These acoustic-energy devices generally are proven to be noninjurious to fishes, though they can disturb and displace fishes and interrupt feeding (Pearson, Skalski, and Malme, 1989). These effects are considered to be limited in area and time and, therefore, without significance to local fish populations.

There also is some evidence that seismic-survey acoustic-energy sources damage eggs and larvae of some fishes (American Petroleum Institute, 1987). This injury apparently is limited to within a meter or two from the airgun-discharge ports. Given the relative low densities and wide distribution of eggs and larvae in Cook Inlet, it is not likely that any large numbers of eggs or larvae would be subjected to this hazard. Thus, it may be assumed that seismic surveys have no appreciable adverse effects on fishes.

Summary: The effects of an oil spill were reviewed for fisheries resources in the sale area. Sale-specific oil-spill effects on fisheries resources were estimated using combined probabilities generated from the OSRA model. Effects on fisheries derived from the EVOS studies were used to estimate potentially lethal effects of an oil spill on fisheries resources. Sale-specific oil-spill effects are not expected to directly affect returning adult salmon or steelhead. Oiled intertidal areas could cause an increased mortality to pink salmon eggs in the affected areas, but the increased egg mortality is not expected to cause reduced adult survival. An increased level of developmental malformations and increased egg-larval mortality could cause reduced survival to adulthood in herring populations affected by an oil spill. These effects are expected to be limited to the year-class spawned during the spill year and be masked to some extent by the contribution of other year-classes to the herring population. Eggs and larvae of some semidemersal and demersal fishes may suffer increased mortality from oil contact. Also, some demersal fish populations could be exposed to oil in the event of a spill, and a few individuals could be killed. Based on the experience of the EVOS, however, it is unlikely there would be any population-level effects to demersal fishes.

Indirect effects such as ingesting oil from contaminated food could cause slower growth of pink salmon juveniles due to the metabolic cost of depurating the hydrocarbon burden. This may cause an incremental reduction in survival to adulthood, but it is not expected to have population-level effects.

Fisheries resources could be disturbed and displaced from the immediate vicinity of drilling discharges, within a radius probably not to exceed 100 m. These effects on demersal fishes very likely would be limited to only the short time periods of the discharge. Offshore construction also could temporarily disturb and/or displace fisheries resources. Any disturbance or displacement should be short term (hours to days), limited to only the time of construction and shortly thereafter. Though seismic-surveys may damage eggs and larvae of some fishes, this injury is limited to within a meter or two from the airgun-discharge ports. Thus, seismic surveys probably would have no appreciable adverse effects on fish populations.

Conclusion: The OSRA estimates there is a 27- percent chance that one or more spills ≥1,000 bbl could occur. Assuming contact (combined probability of >5% of occurrence and contact to specific land or resource segments), the overall estimated effects of an assumed 50,000-bbl-oil spill on fisheries resources are expected to be minimal, with the possible loss of some adult demersal fishes and possible increased mortality of eggs and larvae of pink salmon, semidemersal, and demersal fishes. Disturbance, displacement, or injury as a result of drilling or seismic activities also are expected to be minimal. The various effects to fisheries resources taken altogether are not expected to cause population-level changes.

d. **Effects on Marine and Coastal Birds**: About 100 species and several million marine and coastal birds occur within marine habitats and/or on coastal habitats adjacent to the proposed lower Cook Inlet sale area. Important coastal habitats are shown in Graphic 1. The primary adverse effects on marine and coastal birds from the base-case OCS exploration and development activities in the proposed sale area are expected to come from oil pollution of the marine environment; lesser effects are expected to come from noise and disturbance of bird populations and alteration of habitats.

To aid in the interpretation of the following effects discussion, an explanation of the term "population in the region" is given. A population of marine and coastal birds is (1) the number of a particular species of seabird that breeds within a colony complex or (2) the number of waterfowl or shorebirds of a species that breeds or occurs seasonally within the Cook Inlet Planning Area. A portion of a population in the region would be, for example, the number of waterfowl of one species that occurs seasonally within a particular bay.

(1) Effects of Oil Spills:

(a) General Effects: The effects of oil spills on birds are well documented. (For a detailed discussion of the nature of these effects, see *The Relative Sensitivity of Seabird Populations in Alaska to Oil Pollution* [Hansen, 1981], which is summarized here and incorporated by reference.) Direct oil contact alone usually is fatal and often results in substantial mortality of many birds. Oiling of birds causes death from hypothermia, shock, or drowning. Oil ingestion through preening of oiled feathers significantly reduces reproduction in some birds and causes various pathological conditions such as endocrine dysfunction, liver-function impairment, and significant weight loss and reduced growth in young birds (Holmes, 1985; Harvey, Phillips, and Sharp, 1982; Peakall et al., 1980; Koth and Vank-Hentzelt, 1988). Oil contamination of eggs by oil-fouled feathers of parent birds also significantly reduces egg hatching through toxic effects on the chick embryo or by abandonment of the eggs, chicks, and nest by parent birds (Stickel and Dieter, 1979; Fry et al., 1986; Butler et al., 1988). Oil contamination of brood pouch feathers of black-legged kittiwakes and contamination of eagles resulted in contamination of eggs and cessation of reproduction or reduced nesting success, for that year, as result of the EVOS (Bowman and Schempf, 1993; Irons, 1993).

Indirect potential effects of oil pollution include reduction, contamination, and displacement of food sources as well as contamination of shoreline habitats. Long-term, low-level contamination of food sources and habitats theoretically could lead to chronic toxicity in birds through the accumulation of hydrocarbon residues that may adversely affect their physiology, growth, reproduction, and behavior. The contamination of intertidal prey organisms of harlequin ducks as result of the EVOS apparently resulted in reproductive failure of this species in habitats contaminated by the spill for >3 years (Patten, 1993).

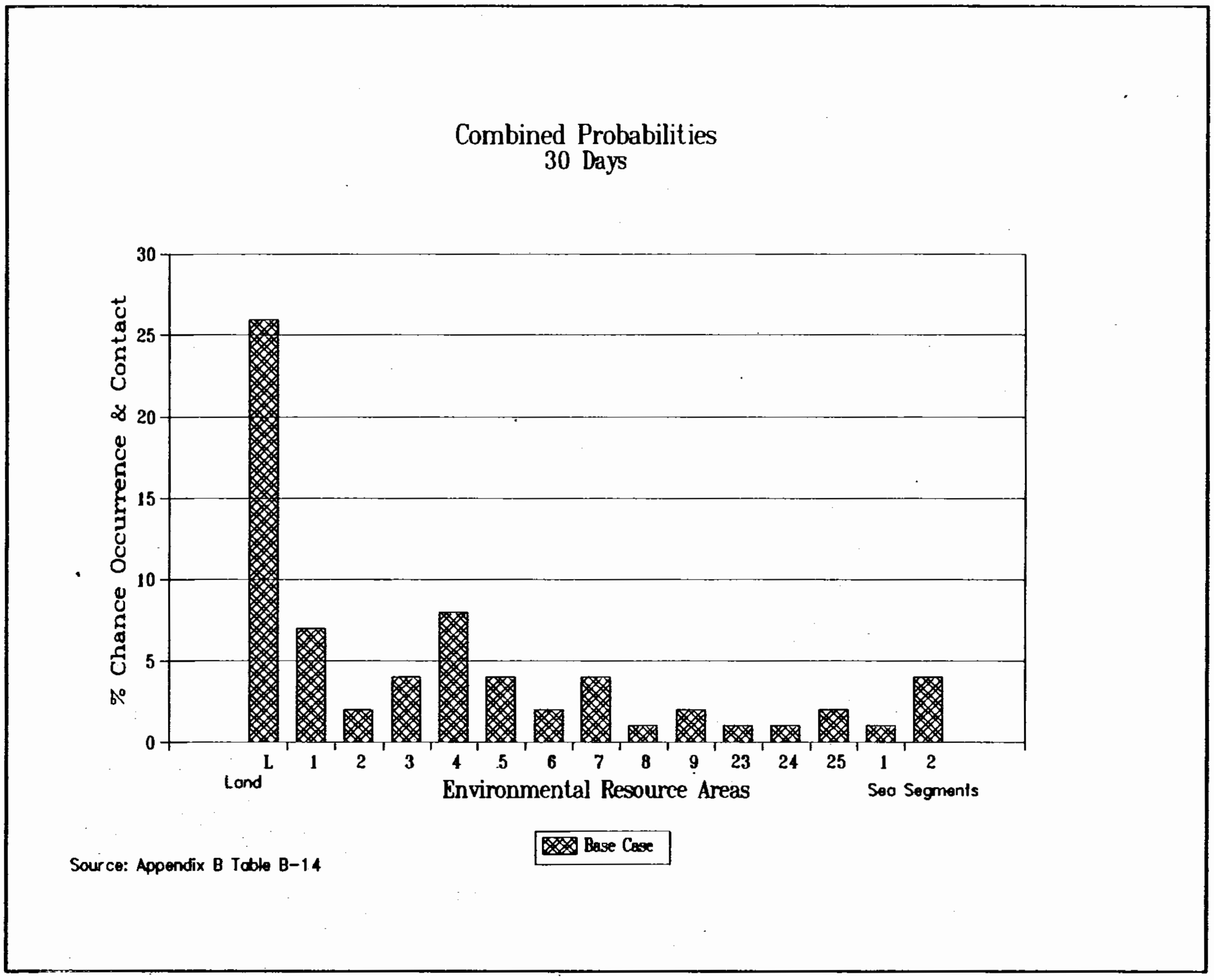
The effects on birds of an oil spill in the Sale 149 area would vary with the season; volume, nature, and duration of the spill; species and numbers of birds occurring in the areas affected; and many other variables.

(b) Site-Specific Oil-Spill Effects: Under the base case of the Proposal, oil development is assumed to occur in the lower Cook Inlet area, with oil transported from three production platforms by a 125 mi-subsea oil pipeline to a landfall located at Nikiski on the Kenai Peninsula (Fig. IV.B.1.d-1).

The OSRA model estimates a mean number of 0.31 spills ≥1,000 bbl are likely to occur as a result of this scenario, with an estimated 27-percent chance of one or more such spills occurring (Table IV.A.2-2). For the purpose of this analysis, this EIS assumes one 50,000-bbl-oil spill will occur (Table IV.A.2-2). The results of the OSRA regarding potential effects on marine and coastal birds and their habitats are as follows. Attention is devoted to spills ≥1,000 bbl, which have a trajectory period of up to 30 days during the summer (April-September) season. Combined annual probabilities of spill occurrence and contact factor in the volume of oil expected to be produced and the estimated spill rates for platforms, pipelines, and tankers. The OSRA estimates a combined probability (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting marine and coastal bird habitats (ERA's 1-9, 23-25; SS 1-2) ranging from <0.5 to 8 percent during the summer season (April to September), while estimated spill occurrence and contact to land is 26 percent (Fig. IV.B.1.d-1). The marine and coastal bird habitat areas, other than land (26% chance of contact), with the highest (>5%) chance of occurrence and contact, are outer Kamishak Bay, Tuxedni Bay, and Cape Douglas area (Fig. IV.B.1.d-1, ERA's 4, 1, and 7, respectively).

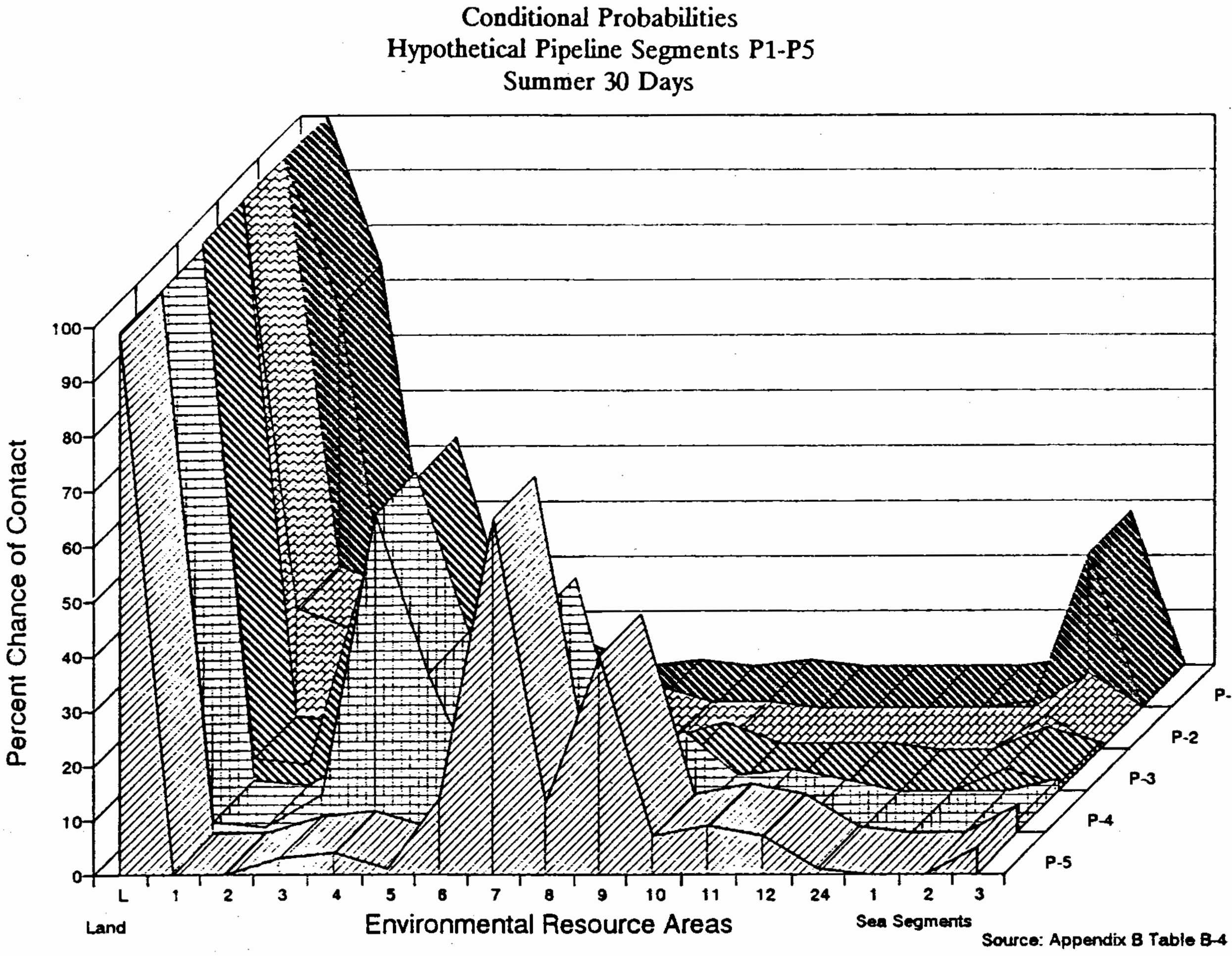
Conditional probabilities assume that oil spills occur at a particular location or along a particular route. The following analysis of conditional probabilities assume that oil spills occur along the pipeline system P1 through P5 in lower Cook Inlet, as shown in Figure IV.B.1.d-2. These estimated conditional probabilities of spill contact in summer after 30 days are much higher than the above combined probabilities, because the conditional probabilities assume a spill occurs at each of the locations or along the route and do not factor in spill rates or the volume of oil assumed to be present under the base case.

The estimated chance of contact of oil spills along the pipeline system, P1 through P5, other than contact to the shoreline-land in general (>99.5%), show the highest estimated chance of contact (>50%) to the following marine and coastal bird habitats: Tuxedni Bay (ERA 1, 73% from P1), Cape Douglas area (ERA 7, 65% from P5), and outer Kamishak Bay (ERA 4, 57-58% from P3 and P4). Fairly high chances of contact occur to the Kukak Bay area (ERA 9, 40% from P5) and Kachemak Bay (ERA 3, 40% from P3) (Fig. IV.B.1.d-2). The conditional probability of spill contact to SS's 1, 2, and 3 from potential oil spills along P1 through P5 reflect the



Source: Appendix B Table B-14

Figure IV.B.1.d-1. Combined Probabilities (expressed as percent chance) of One or More Spills ≥ 1,000 Barrels Occurring and Contacting Certain Environmental Resource Areas With 30 Days Over the Production Life of the Sale 149 Area.



Source: Appendix B Table B-4

Figure IV.B.1.d-2. Conditional Probabilities (expressed as percent chance) that During the Summer Season, an Oil Spill Starting at a Hypothetical Spill Location (Pipeline Segments P1-P5) Will Contact a Certain Environmental Resource Area Within 30 Days.

chances of spills moving southward through Shelikof Strait. The chance of contact to SS's 1, 2, and 3 reflect the higher chances (28% chance of contact to SS 2 from P1) of spill contact to marine habitats in the Kalgin Island area and southward, as shown in Figure IV.B.1.d-2. If an oil spill from P1 through P5 moved south out of Shelikof Strait (<0.5-5%, SS 3), it could contact part of the Semidi Islands (ERA 16) seabird foraging habitat within 30 days during summer. If the Semidi Islands areas were contacted, several thousand murres and other seabirds could be affected.

Conditional probabilities of spill contact, shown in Figure IV.B.1.d-3, assume that spills occur in association with oil tankering (T1-T4) and pipelines (T1-T2) in Cook Inlet; the chances of contact to marine and coastal bird habitats from spills during summer within 30 days along the tanker route from the Nikiski terminal into the Gulf of Alaska are the highest (>40%) for the Barren Islands (ERA 6, 95% from T4), Kachemak Bay (ERA 3, 63% from T3), and Kamishak Bay (ERA 4, 47% from T3) areas. The high (61%) estimated chance of spill contact from the northernmost segment of the tanker route and pipeline (T1) to SS 2 located just south of Kalgin Island reflects the chance of tanker or pipeline spills moving south from the Nikiski terminal area in lower Cook Inlet (Fig. IV.B.1.d-3).

Conditional probabilities of spill contact, shown in Figure IV.B.1.d-4, assume that tanker spills occur along a tanker route (T5-T8) through the western Gulf of Alaska. The following seabird-habitat areas have a comparatively high (>20-98%) chance of being contacted by oil spills along the route during summer within 30 days: Portlock Bank (ERA 25, 98% from T6 and 67% from T7), the Barren Islands (ERA 6, 52% from T5), Northern Albatross Banks (ERA 23, 24% from T7), Marmot Island area (ERA 24, 23% from T6), and Shuyak Island area (ERA 8) (see Figs. IV.B.1.d-3 and 4).

If the assumed 50,000-bbl-oil spill occurred along either of these tanker routes, it is expected to result in substantial mortality of diving seabirds (such as tens of thousands of murres) near the Barren Islands. If the spill sweeps through this area in the fall when aggregations of flightless adult murres and their offspring are rafting on the water near the colonies, the loss of several thousand adult breeding birds and their young is expected. If the spill spreads over through parts of the seabird-feeding areas on the Portlock and northern Albatross Banks, species of seabirds that feed in these areas are expected to suffer losses, perhaps in the thousands.

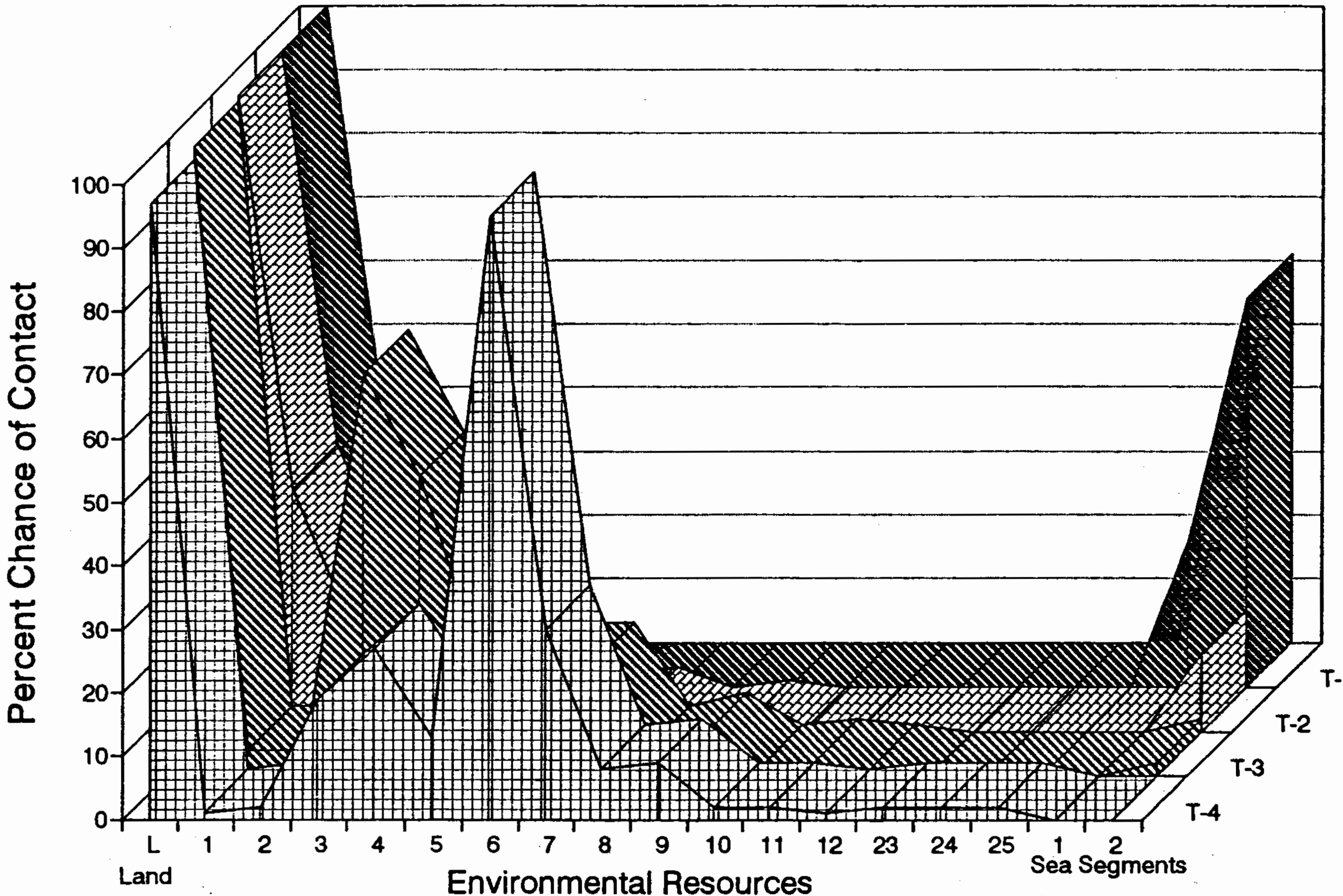
Within lower Cook Inlet, bird habitats and populations that are expected to come in contact with the assumed spill would be sea duck and other waterfowl populations in outer Kamishak Bay and Kachemak Bay and seabird populations of the Chisik-Duck Islands in the Tuxedni Bay area.

If a potential platform spill occurs within about 10 mi of the Tuxedni Bay area (ERA 1), there is an estimated conditional probability (expressed as percent chance) >75 percent chance of contact with this important marine- and coastal-bird habitat within 30 days during the summer (Appendix B, Fig. B-1). If a potential platform spill occurs within 10 mi of Kachemak Bay (ERA 3), there is an estimated >25-percent chance of contact with this important marine- and coastal-bird habitat area within 30 days during the summer (Appendix B, Fig. B-3).

Depending on spill size (50,000 bbl) and spread (over an area 3,458-3,715 km^2, depending on the season, as a discontinuous slick) of the spill, several thousand or more birds are likely to be affected by a spill in nearshore waters of lower Cook Inlet, while probably fewer birds would be contaminated if the spill remained offshore. Assuming the spill swept through a coastal area when and where aggregations of rafting seabirds near Chisik-Duck Island (Tuxedni Bay) were congregating prior to breeding in the spring or during the fall, several thousand murres and other seabird species are expected to be killed. Some of these seabird populations (such as the murres) are expected to take more than one generation (probably no more than 3 generations or about 15 years) to fully recover from these losses. Assuming the oil spill contacts outer Kachemak or Kamishak Bays, several thousand—up to a total of perhaps 100,000—sea ducks, shorebirds, and local seabirds are expected to be directly lost to the spill.

Assuming the 50,000-bbl-oil spill contacts coastline and important intertidal habitats of sea ducks and shorebirds in lower Cook Inlet (26% chance of occurrence and contact to land in Fig. IV.B.1.d-1), contamination of intertidal prey organisms of sea ducks and shorebirds, such as intertidal mussels, is expected to occur. This contamination is expected to affect productivity of local sea ducks that depend on these food sources through ingestion by the birds of petroleum hydrocarbons on and within the mussels or other invertebrate food sources oiled by the spill. This contamination of habitat and resulting effect is expected to last for >1 to a number of years after the spill (see discussion in Sec. IV.B.1.d.(1)(a) citing Patten, 1993).

Conditional Probabilities
Tanker Route T1-T4 and Pipeline T1-T2
Summer 30 Days



Source: Appendix B, Table B-4

Figure IV.B.1.d-3. Conditional Probabilities (expressed as percent chance) that During the Summer Season, an Oil Spill Starting at a Hypothetical Spill Location (Tanker Route T1-T4 and Pipeline T1-T2) Will Contact a Certain Environmental Resource Area Within 30 Days.

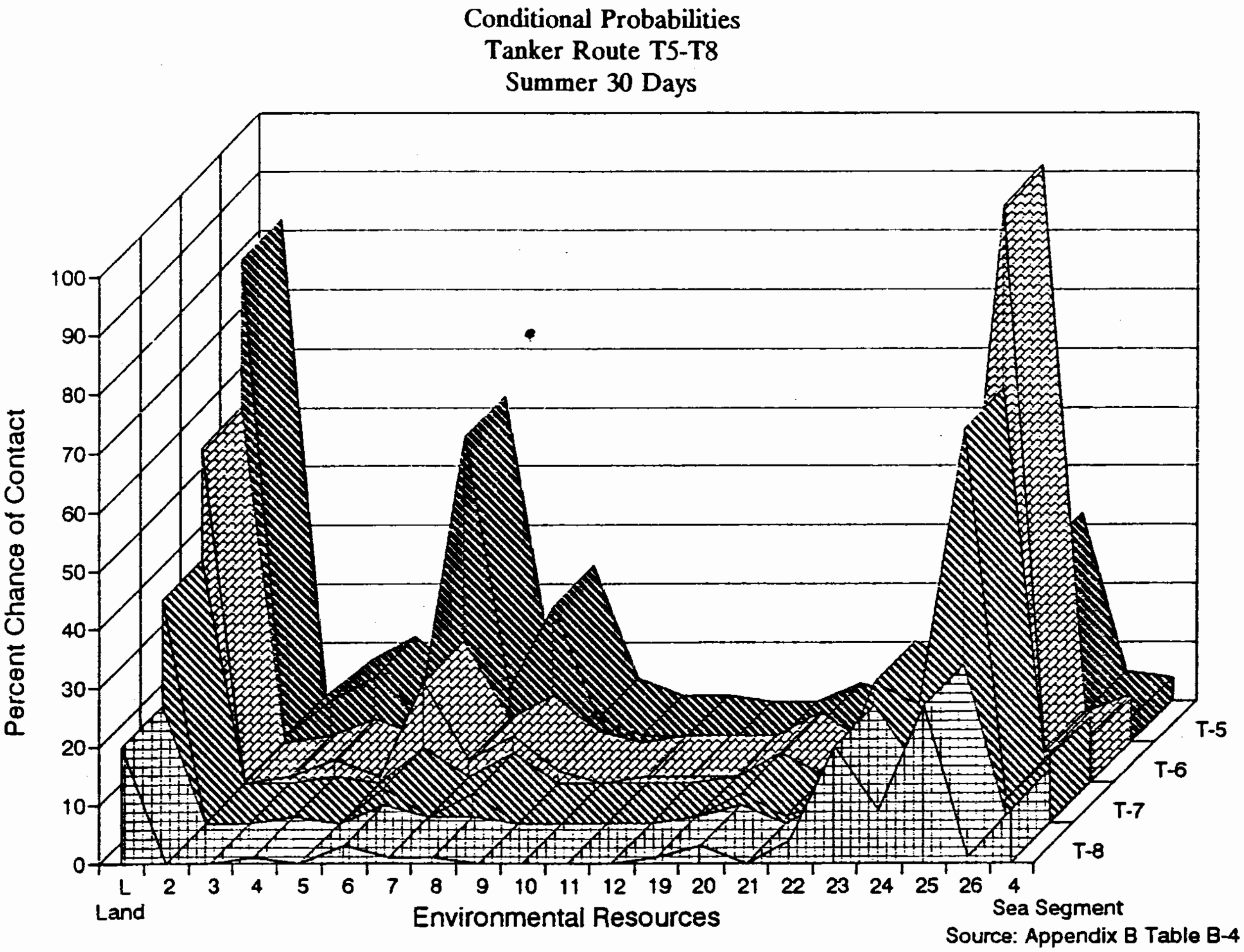


Figure IV.B.1.d-4. Conditional Probabilities (expressed as percent chance) that During the Summer Season, an Oil Spill Starting at a Hypothetical Spill Location (Tanker Route T5-T8) Will Contact a Certain Environmental Resource Area Within 30 Days.

A total of 47 small oil spills <50 bbl and 2 spills ≥50 bbl but <1,000 bbl also are assumed to occur under the base case (Table IV.A.2-4d). These minor spills are expected to have an additive effect on marine and coastal bird losses, perhaps increasing losses by a few thousand birds and increasing habitat contamination by perhaps about 1 percent.

(2) Effects of Noise and Disturbance:

General Effects: Human activities associated with OCS exploration and development, especially air traffic near nesting waterfowl and seabirds, could reduce the productivity of some local bird populations and may cause temporary (perhaps 1 hour) abandonment of important nesting, feeding, and staging areas. Studies of the effects of the EVOS suggest that noise and disturbance associated with intensive oil-spill-cleanup activities (>11,000 people, 1,430 vessels, and 84 aircraft) contributed to the displacement and reproductive failure of many species of nesting birds in oiled areas in Prince William Sound.

The responses of birds to human disturbances (including aircraft) are highly variable. These responses depend on the species; the physiological or reproductive state of the birds; distance from the disturbance; type, intensity, and duration of the disturbance; and many other factors. The movement and noise of low-flying aircraft passing near seabird colonies often frightens most or all adult birds off their nests, leaving the eggs and young vulnerable to exposure, predation, and accidental displacement from the nest (Jones and Peterson, 1979). Evidence has indicated that repeated disturbance could significantly reduce hatching and fledgling success and perhaps cause some adults to abandon their eggs and young (Scott, 1976). However, thick-billed murre colonies located near an airport where they were subject to high levels of aircraft disturbance did not show significant decrease in reproductive success compared to other thick-billed murres that nested away from the airport (Curry and Murphy, 1995). Potential disturbance of nesting seabirds at locally important colonies on the Chisik-Duck Islands or smaller colonies along the western coast of the Kenai Peninsula is a primary concern (Graphic 1). The major seabird colonies on the Barren Islands are far enough away from the sale area (over 10 nmi) and not near the expected air-traffic route associated with the proposal to be potentially be affected by noise and disturbance.

Aircraft disturbance of waterfowl has been shown to cause lower nesting success of Pacific brant and common eider (Gollup, Goldsberry, and Davis, 1972). Repeated air-traffic disturbance of concentrations of feeding and molting waterfowl and shorebirds on coastal lagoons and other wetlands may reduce the ability of migratory birds to acquire the energy necessary for successful migration. If such disturbance occurred frequently, migration mortality might increase and winter survival of affected birds might be reduced.

(3) Specific Effects of Noise and Disturbance:

(a) Exploration Activities: For exploratory drilling under the base case of the Proposal, one drilling unit is expected to be used each year. Platform-installation activities associated with exploration temporarily could displace (1 season) several birds near the platform-installation site. Some brief displacement (perhaps a few minutes to <1 hour) of birds could occur because of noise and movement of aircraft traffic (60 helicopter flights/month) between the Kenai/Nikiski area and the drill platforms in the lower Cook Inlet area and due to boat traffic (30 supply boats/month) between the drill platforms and harbor facility in the Kenai area. These effects are expected to be local, within about 1 mi of the aircraft- and boat-traffic routes; and disturbance of birds along these traffic routes is expected to be short term, a few minutes to <1 hour for aircraft and boat disturbance of birds and one season or about 3 months for platform-installation activities.

(b) Development and Production: During oil-field development under the base case of the Proposal, aircraft and supply-boat traffic to and from the three production platforms is expected to increase to 60 to 120 helicopter trips/month and 30 to 60 marine supply boat trips/month. This traffic would increase the frequency of potential disturbance of birds along the traffic routes. Aircraft traffic (below 1,500 ft and within 1 mi of the colony) is expected to be more disturbing to nesting seabirds than the boat traffic. Assuming that aircraft disturbance occurs for each helicopter trip (60-120/month or 4/day) for some seabird colonies along the traffic route (a worst-case situation), productivity and nesting success of the exposed colonies might be reduced over the life of the oil field. However, the analysis assumes that the oil industry and its contractors would comply with the ITL on Bird and Mammal Protection and avoid flying within 1 mi of seabird colonies and known bird-concentration areas when weather conditions permit them to avoid these areas (see Sec. II.H, Mitigating Measures).

This compliance is expected to prevent excessive or frequent disturbance of seabird colonies and waterfowl and shorebird-nesting- and -feeding-concentration areas that might lead to lower productivity and nesting success.

In the event of a large oil spill contacting and extensively oiling coastal habitats with concentrations of nesting birds, the presence of several thousand humans, hundreds of boats, and several aircraft operating in the area involved in cleanup activities are expected to cause displacement of nesting birds in the oiled areas and contribute to reduced reproductive success of the birds. This effect is expected to persist during cleanup operations (perhaps 1 or 2 seasons) and affect birds within about ≤1 mi of the activity.

(4) <u>Effects of Habitat Alteration</u>:

<u>Pipeline Development</u>: The proposed action is assumed to include the laying of one 125-mi long subsea offshore pipeline from an assumed two production platforms in lower Cook Inlet to a landfall at Nikishka on the Kenai Peninsula. This pipeline laying is expected to alter several miles of benthic habitat and could have temporary effects on the availability of food sources of some sea ducks very near or within a mile or two of the pipe-laying operation due to turbidity and removal of prey organisms along the pipeline route, representing a short-term (1 season) effect.

<u>Summary</u>: Noise and disturbance would come from air (60-120 flights/month) and marine-vessel (60 trips/month) traffic and offshore habitat alteration (a few square kilometers) from offshore pipeline laying and installation of eight exploration and three production platforms. These effects are expected to be local (within 1 mi of the traffic, platform, and pipelines) and short term (<1 hour for air- and vessel-traffic-disturbance events to <1 year for pipeline- and platform-construction activities). Oil-spill effects on marine- and coastal-bird populations or portions of populations within the region are expected to include the loss of several thousand birds, with full recovery from the spill to take more than one generation (probably <3 generations or <15 years), particularly on murre populations, which are expected to suffer substantial mortality (several thousand losses). The assumed 50,000-bbl spill is expected to contact coastal intertidal habitats and local food sources of sea ducks and shorebirds in lower Cook Inlet. This contamination is expected to result in reduced productivity (reproduction) of portions of the sea duck and/or shorebird populations through the ingestion of petroleum hydrocarbons on and within food items (such as mussels).

The contamination is expected to persist for several years after the spill, and bird reproduction is expected to be affected for >1 year.

The overall effect of the proposal is expected to involve the loss of several thousand—up to a total of perhaps 100,000—birds from the spill with recovery taking place within a few years to more than one generation (probably <3 generations or 15 years), depending on the status of the affected populations during the time of the spill. This conclusion was based on the high sensitivity of birds to an oil spill and the assumption that a 50,000-bbl spill will occur; the habitats and populations of marine and coastal birds most expected to be affected is determined by the combined probabilities ≥5 percent and conditional probabilities ≥50 percent estimated to occur along the tanker or pipeline route. The general threshold for both combined and conditional probabilities for assuming contact was ≥1 percent.

<u>Conclusion</u>: The overall effect on marine and coastal birds (primarily due to the assumed 50,000-bbl-oil spill and assuming most likely spill contact to bird habitats with a combined probability ≥5%) is expected to include the loss of several thousand—up to a total of perhaps 100,000—birds, with recovery taking more than one generation (probably <3 generations or <15 years). Sea ducks and shorebirds are expected to suffer reduced productivity in areas where intertidal-habitat contamination from the spill persists for a number of years, with this local effect expected to last for >1 year to perhaps several years.

e. <u>Effects on Nonendangered Marine Mammals (Pinnipeds, Cetaceans, and the Sea Otter)</u>: Nine species of nonendangered marine mammals commonly occur in the lower Cook Inlet region. All marine mammals are protected species under the Marine Mammal Protection Act of 1972 (MMPA), as amended. Primary factors that may have deleterious effects on marine mammals in the sale area under the base case are oil spills, noise and other disturbances associated with exploration and development (e.g., seismic activities, marine and aircraft traffic), and habitat loss and/or alteration. This analysis considers the potential effects of these factors on individual pinnipeds, cetaceans, and sea otters, including the effects of the EVOS, followed by population-level effects on each species on a sale-specific basis.

(1) Direct Effects of Oil Contamination: The effects of oil on marine mammals will vary by species and such factors as age, condition, reproductive status, pre-existing disease, and environmental stress. These effects have been recently reviewed by Hansen (1992) and Geraci and St. Aubin (1990).

Oil can affect marine mammals through direct contact with the skin surface, inhalation of PHC vapors, ingestion, or by the alteration of their normal patterns of behavior. In particular, sea otters spend most of their time grooming or resting on the water surface, where floating oil can accumulate, and so are directly exposed to these effects.

(a) Contact: Certain PHC's can irritate and damage some mammalian skin, with contact effects progressing from localized reddening to ulceration and inflammation (Walsh et al., 1974; Hansbrough et al., 1985). The PHC's can be irritating to sensitive tissues such as the mucous membranes around the eyes and mouth and respiratory surfaces as well as the anal and genital orifices. Experimentally placed ringed seals showed an irritation reaction within minutes after exposure to crude oil and water. After 24 hours, they developed corneal abrasions and ulcers, conjunctivitis, and swollen nictitating membranes. All symptoms and inflammation subsided after the seals were placed in clean water (Smith and Geraci, 1975).

Direct contact of heavy crude oil can interfere with locomotion in very young pinnipeds (Davis and Anderson, 1976). An experimentally applied benzene derivative did cause an allergic-dermatitis response in one of three harp seals tested, indicating that direct contact effects of some of the more toxic PHC fractions can occur with pinnipeds (Geraci and St. Aubin, 1985).

Experiments indicate cetacean skin is more resistant to crude oil and other PHC's. Gasoline-saturated sponge disks were placed directly on the skin of two dolphin species for up to 75 minutes and on human skin for up to 35 minutes (Geraci and St. Aubin, 1982). Subtle effects evident only by close histological scrutiny were detected in the dolphins, and these healed within 1 week (Geraci and St. Aubin, 1982; Geraci, 1990). In contrast, the human subjects exhibited a distinct reddening that did not return to normal coloration for 10 days with most subjects and up to 7 months in one (Geraci and St. Aubin, 1982). This profound difference in response shows cetacean skin to be an effective barrier to toxic fractions of PHC's at exposures ranging up to 75 minutes long. Cetaceans are more likely to encounter crude or weathered oil rather than the more toxic gasoline, and for shorter timeframes than in the experiments. Thus, contact effects on the cetacean skin would be even less than the minor reactions shown in the experiments (Geraci, 1990).

The primary concern with some pinniped species and the sea otter lies in the fouling and contamination of their pelage, thereby impairing thermoregulation. Some pinnipeds are protected from cold temperatures by a thick, subcutaneous blubber layer. However, fur seals and sea otters depend on their dense fur to trap air and act as a thermal barrier. Oil fouling reduces the thermal- barrier qualities of their fur. Thermal conductance of oiled fur is increased and, subsequently, so is metabolism. This can result in pneumonia or hypothermia of the affected animal (Costa and Kooyman, 1980, 1982). Oiling will increase stress and decrease foraging ability. Free-ranging sea otters seem able to withstand low levels of oiling if only ≤20 percent of their pelt is oiled. But oiling of >30 percent of a sea otter pelt likely will result in death for the affected sea otter (Costa and Kooyman, 1980, 1982). Fur seals oiled on one-third of their body surface suffered a 50-percent-greater heat loss than unoiled seals (Kooyman, Gentry, and McAlister, 1976). Oil fouling had no effect on the insulative value of sea lion and ringed seal pelts but some effect on weddell seals (Kooyman, Davis, and Castellini, 1977). Newborn harbor seals have not developed the blubber layer to the degree of adults and are not protected from the effects of low temperatures. Thus, oil fouling of fur seal, harbor seal pup, and sea otter pelage would cause a loss of thermal protection.

(b) Inhalation: Perhaps the greatest threat to marine mammal health in the event of an oil spill is their exposure to toxic PHC vapors present at the narrow air-water or air-oil interface where they breathe. The effects of PHC inhalation on marine mammals have not been directly studied, though data do exist pertaining to other mammals. In humans, inhalation effects of highly concentrated oil vapors include inflammation and damage to mucous membranes of airways, lung congestion, pneumonia, and pulmonary edema (Zieserl, 1979). Many laboratory species show similar effects such as pulmonary hemorrhage, inflammation, and congestion (Carpenter et al., 1975 and 1976, as cited in St. Aubin, 1990). Pinnipeds under stress combined with exposure to PHC vapors may succumb due to synergistic effects of the stress and PHC's. St. Aubin (1990) thought it unlikely that free-ranging pinnipeds would encounter vapors concentrated enough to pose a health threat.

The severity of inhalation effects on cetaceans would depend on the concentration of vapors, duration of exposure, the health of the individual, and its response to stress (Geraci, 1990). Whales that rapidly respire due to a panic response or response to harassment by cleanup vessels or other air or waterborne craft probably would inhale more of the toxic vapors. The combination of stress and inhalation of PHC vapors may exacerbate the effects (Geraci, 1990).

(c) **Ingestion:** The PHC's can be toxic if swallowed (Neff, 1990), and marine mammals can ingest oil directly when consuming contaminated prey or when nursing. Potential effects on mammals range from death to progressive organ damage (St. Aubin, 1990). Controlled experimental studies on the effects of oil ingestion were completed on harp and ringed seals (Smith and Geraci, 1975; Geraci and Smith, 1976; Englehardt, 1982) and bottlenose dolphins (Geraci, 1990). These studies did not measure lethal thresholds for oil ingestion. The work demonstrated that harp seals, ringed seals, and dolphins could tolerate small quantities of ingested oil. Furthermore, extrapolating toxic effects of PHC ingestion on rats and mice to marine mammals indicated that a phocid seal weighing 50 kilograms (kg) would have to ingest several hundred milliliters of oil, a harbor porpoise would need to ingest 1 liter (l), a pilot whale 30 l, and a 40-ton whale (such as a fin whale) 600 l to result in toxic effects.

Cetaceans are most at risk of ingesting PHC's during feeding. Toothed whales (odontocetes), including the sperm and beaked whales, killer whales, and other dolphins and porpoises pursue and catch their prey. They probably hold individual or small bunches of prey in their relatively small oral cavity prior to swallowing. Thus, toothed whales are not likely to ingest large quantities of oil while feeding. In contrast, baleen whales (mysticetes) have a very large oral cavity and intake a relatively larger volume of water while straining out the small prey items (zooplankton, small fishes) that comprise their diet. Baleen whales feeding in an oil slick or in oil-polluted waters may ingest oil in the process. Further, their straining apparatus (baleen) may become fouled with oil, reducing its ability to function properly during feeding.

Studies have shown that oil-fouled baleen decreases whale-feeding efficiency, but the reduced efficiency was temporary and diminished through time (Geraci and St. Aubin 1982, 1985; Braithwaite, 1983). Also, healthy sei whales with rudimentary baleen plates have been observed (Rice, 1961), indicating that a full complement of well-developed baleen is not necessary for normal sei whale growth.

The PHC's can be stored in blubber, and the activation and mobilization of the fat stores during molt or reproduction could enhance their toxicity (St. Aubin, 1990). However, the subtle effects of such sublethal levels of PHC's may be evident only through careful, long-term monitoring and/or controlled studies.

(d) **Behavior:** Behavioral effects that PHC's can have on pinnipeds include interference with female/pup interactions—bonding, recognition, and the disruption of nursing. Reduced or impaired mother/pup recognition can lead to pup abandonment or even female aggression towards a pup unidentifiable as its own. Disruption of nursing can lead to reduced pup weight gain that can deleteriously affect pup survival, though an early study of oil and grey seals showed no effect on seal nursing behavior due to the oiling (Davis and Anderson, 1976).

Cetacean behavior could be affected by an oil spill or by chronic oil pollution. Cetaceans might detect and avoid oiled areas that are important habitat, such as feeding grounds or breeding and calving areas. Gray whales may modify their swimming speed though oiled areas; they would blow less frequently but at an increased rate, thereby spending less time on the surface (Evans, 1982).

(2) **Effects of Oil Spills, Including the *Exxon Valdez* Oil Spill:** Oil spills of many types occurring over the last 26 years have affected marine mammals to varying degrees (Table IV.B.1.e-1). Pinnipeds spend a portion of activities hauled out on land, so they must enter and leave water or land passing through the water surface where floating oil collects. Cetaceans have been observed in the presence of many past oil spills, but there has been little or no direct evidence to link a spill event to any cetacean mortality discovered either during or postspill. Free-swimming marine mammals should be able to detect the presence of oil through their sensory systems and then avoid it if they choose. But in some instances, they have not avoided oiled areas. After the 1969

Table IV.B.1.e-1
Some Major Oil Spills that Contacted Marine Mammals

Year of Spill	Location/Sources	Oil Type/ Quantity	Species	Effects	References
1967	English Channel *Torrey Canyon*[1]	Crude oil, 30 million gal	Gray seal	12 deaths confirmed.	Gill et al., 1967 Spooner, 1967
1969	Santa Barbara Channel Platform blowout	Crude oil, >30 million gal	Harbor and elephant seals; California sea lion; gray, pilot, sperm whales; common and Pacific white-sided dolphins	Oiled seals. 16 stranded cetaceans, no causal relationship to oil.	LeBoeuf, 1971; Brownell and LeBoeuf, 1971; Brownell, 1971
1969	Gulf of St. Lawrence Storage tank	Bunker C, 4,000 gal	Harp seal	10,000-15,000 seals oiled; number of dead unspecified.	Warner, 1969 Seargent, 1987
1970	Chedabucto Bay, Sable Island, N.S. *Arrow*[1]	Bunker C, 4 million gal	Gray and harbor seals	660 seals oiled, 24 dead.	Anonymous, 1970; 1971
1974	Skomer Island Unknow source	Unknown	Harbor and gray seals	2 pups encased in oil drowned; 48 total seals fouled.	Davis and Anderson, 1976
1976	Nantucket Shoals *Argo Merchant*[1]	Bunker C, 7.9 million gal	Fin and pilot whales, other cetaceans	43 sightings in and around oil; no obvious reaction.	Grose and Mattson, 1977
1979	France *Amoco Cadiz*[1]	Crude oil, 60 million gal	Gray seal; common and white -sided dolphins; pilot whale	2 of 4 dead seals oiled, no causal relationship; 6 stranded cetaceans, no evidence of oil.	Prieur and Hassenot, 1978
1979	Cape Cod, Mass. *Regal Sword*[1]	Bunker C, 80,000 gal; fuel oil, 6,300 gal	Humpback, fin, minke, right whales; white-sided dolphin	Animals feeding, surfacing, and swimming in heavy oil concentrations.	Goodale et al., 1981
1987	Anvers Island, Antarctica *Bahia Pariso*[1]	Diesel fuel, 233,000 gal	Crabeater and elephant seals, southern fur seal	2 crabeaters affected, elephant and fur seals oiled but unharmed.	Anonymous, 1989; De Lace, as cited in St. Aubin, 1990
1989	Prince William Sound *Exxon Valdez*[1]	Crude oil, 11 million gal	Harbor seal; Steller sea lion; gray, fin, minke, killer, and unidentified whales; harbor porpoise	345 harbor seals estimated dead; 36 stranded carcasses, unrelated natural mortality likely; 13 missing killer whales.	Frost and Lowry, 1993; Loughlin, personal comm., ; Dahlheim and Matkin, 1993

Source: USDOI, MMS, Alaska OCS Region, 1993.

[1] Tanker accident.

Santa Barbara platform blowout, seals and sea lions were not reluctant to enter oiled waters around the Channel Islands (Batelle Memorial Institute, 1969), and gray whales were observed migrating through an oil slick with no apparent reaction (Easton, 1972). Gray seals were observed surfacing through the *Torrey Canyon* spill slick (Gill, Booker, and Soper, 1967); and Steller sea lions and harbor seals were repeatedly surfacing in oiled waters during the EVOS. In the 1979 *Regal Sword* oil spill, right, humpback, and fin whales all were swimming in close association to a heavy slick—some even feeding—with no apparent difference in behavior to other whales observed outside the oiled area (Goodale, Hyman, and Winn, 1981).

Captive dolphins have shown the ability to detect oil in an enclosed pool by using vision and echolocation and by responding to the tactile sensation of oil to their skin (St. Aubin, 1990). Yet, during spill events in Texas waters (Aransas Pass, crude oil; Matagorda Bay, fuel oil), bottlenose dolphins were observed swimming regularly through both spills with no apparent change in behavior or deleterious effects (Shane and Schmidly, 1978; Gruber, 1981). It appears that some cetaceans can detect and avoid oil but do not necessarily do so during an oil spill.

(a) **The *Exxon Valdez* Oil Spill**: Marine mammals known to have been contacted by the EVOS include the Steller sea lion, Pacific harbor seal, killer whale, and sea otter. Effects on the Steller sea lion can be found in Section IV.B.1.f, Endangered and Threatened Species.

1) **Pinnipeds:** Harbor seals in Prince William Sound (PWS) were exposed to oil from the EVOS during the spring and summer of 1989. The seals did not avoid the oil and were observed swimming though it immediately after the spill, when toxic aromatic PHC's were present in the highest concentrations. At least 468 seals were oiled, and most them heavily (Frost and Lowry, 1993). During the pupping season of May and June, both females and pups were oiled. Oiling was most severe in the central PWS, although oiled seals were documented on the Kenai Peninsula and the Barren Islands.

Although hauled-out harbor seals are well known as difficult to approach without "spooking" into the water, after the spill, seals in oiled areas were lethargic and unusually tame, often allowing close approach (Frost and Lowry, 1993). Nineteen recently dead seals (including 13 pups) were necropsied in 1989. Most necropsied seals were too decomposed for proper analysis, but two appeared to be hit by boats and some dead pups seemed to have suffered from malnutrition and stress. Twenty-eight seals were collected and examined—all appeared normal externally, although some were oiled. Conjunctivitis was found in six seals from oiled areas. Microscopic examination of tissues found debilitating brain lesions (mostly the thalamus) in some oiled seals. These lesions were most severe in an animal collected in early April (Frost and Lowry, 1993), when the spilled oil was relatively fresh. Other effects included intramyelenic edema; high PHC metabolites in seal bile (indicative of oil inhalation, absorption, or ingestion); and increased levels of PHC's in blubber, mammary tissue, and milk (Frost and Lowry, 1993).

Aerial-survey-trend counts during the molt were made in oiled and unoiled areas during 1989, 1990, and 1991 in an attempt to estimate mortality due to the spill. Results suggested reductions in pupping rates and total numbers of seals (31%) at oiled sites in 1989. Though the recent decline in PWS harbor seal numbers (Pitcher, 1989; Frost et al., 1991) complicated the analysis, lower trend counts in the oiled areas estimated 345 harbor seals killed by the EVOS (Frost and Lowry, 1993).

2) **Cetaceans:** During the EVOS, six different pods of killer whales were observed transiting directly though a light sheen of oil. One of these, the AB pod, frequents the waters of PWS. Photoidentification studies on this group of whales indicate either unusually high mortality or missing whales—7 in 1989 and 6 in 1990, for a total of 13 missing whales in the 2 years postspill (Dahlheim and Matkin, 1993). The cause of death or whereabouts of these whales is unknown. Some speculate that the whales may have been displaced by the commotion associated with the spill and cleanup in 1989 and 1990 and have yet to be resighted (Loughlin, 1993a and b, personal comm.). Alternately, they may have been shot as a consequence of the black cod longline fishery interaction with killer whales. Dahlheim and Matkin (1993) believe that the 1989 missing animals were killed by the spill, and mortality in the year following the spill was due to long-term effects suffered in the spill year, although there is no direct evidence to support their beliefs.

Humpback whales also were observed and studied in PWS during and after the EVOS (von Ziegesar and Dahlheim, 1993). Whale distribution around lower Knight Island Passage was different in 1989 than in 1988 but appeared normal in 1990, indicating that there was no measurable effect of the EVOS on humpback whales.

As researchers and spill-response workers combed the Alaskan coastline in 1989, a total of 36 beach-cast cetacean carcasses were discovered (Loughlin, 1993, personal comm.). Of these carcasses, 26 were gray whales, 1 was a fin whale, 2 were minke whales, 3 were unidentified whales, and 4 were harbor porpoises. Most of these animals were in advanced stages of decomposition, and field necropsies could not determine cause of death. Laboratory studies on tissue to determine the presence and amount of PHC's were positive in blubber of a few gray whales, but not at lethal dosages. The amount of PHC's present was more indicative of whales swimming through oil and inhaling some PHC vapor (Loughlin, 1993, personal comm.). None of the other beach-cast animals indicated contact with spilled oil. Although the number of cetacean carcasses discovered was higher than usual, it may merely reflect the intensive shoreline search effort during the spill response and not oil-spill mortality.

3) <u>Sea Otters</u>: Up until the 1989 EVOS, sea otters in the United States had remained relatively unaffected by recent oil spills, largely because no spills had occurred along their current range (for a historical perspective, see Kenyon, 1969; Geraci and Williams, 1990).

Effects of the EVOS on the sea otters of PWS, the Kenai Peninsula, and the Kodiak Island/Alaska Peninsula area were profound. Sea otters contaminated during the spill suffered from a variety of ailments, including interstitial pulmonary emphysema, gastric erosion/ulceration and hemorrhage, renal and hepatic lipidosis and necrosis, hypothermia, stress, and shock. Stress and shock also resulted from capturing and cleaning in addition to oiling. All of the above effects contributed to sea otter mortality associated with the EVOS (Lipscomb et al., 1993).

The minimum estimate of sea otter acute mortality based on total number of carcasses was 904 after adjusting for the number of otters that died prespill but were recovered by spill-response teams. The distribution of carcasses was 424 in PWS, 167 along the Kenai Peninsula, and 190 around Kodiak Island and the Alaskan Peninsula (Doroff et al., 1993). Proportions of dead sea otters varied across geographic area and age-class. Data indicate that sea otters closest to the spill site were affected regardless of age-class, as evidenced by the high proportion of adult otters oiled. Pups were affected in higher proportions further from the spill source. This suggests adult sea otters were able to either avoid contamination or withstand low levels of contamination in areas distant from the spill.

Extrapolation from an experiment on carcass-recovery rate estimated a total of 4,028 sea otter deaths resulting from the spill over the entire spill area and 2,209 for PWS (Doroff et al., 1993). Sea otter spill-related acute mortality also was estimated by another method that compared ratios of animals counted in years prior to the spill to counts made after the spill. The number of sea otter deaths estimated from this method for PWS otters was 2,800, with a confidence interval of 500 to 5,000 otters (Garrott, Eberhardt, and Burn, 1993).

(3) **<u>Sale-Specific Effects of Oil Spills</u>:** To help estimate the potential effects of an oil spill for proposed Sale 149, an oil-spill-risk analysis was performed for the lower Cook Inlet area. (Readers interested in more detail on the model and the assumptions used are directed to Sec. IV.A. 2.a). The following section describes the potential effects of oil contact to marine mammal species in the sale area using the OSRA-model results.

(a) <u>Assumptions of the Probability Analysis</u>: The OSRA model estimates a mean number of 0.31 spills ≥1,000 bbl are likely to occur as a result of this scenario, with an estimated 27-percent chance of one or more such spills occurring. For the purposes of analysis, this EIS assumes one 50,000-bbl spill will occur (Table IV.A.2-2). A complete presentation of oil-spill statistics associated with this proposal also is given in Section IV.A.2.a.

(b) <u>Assumptions of the Effects Analysis</u>: This analysis will focus on the summer-season 30-day timeframe, when the highest numbers of marine mammals are expected to be present in the sale area.

The combined probabilities will be used to determine the most likely environmental resource areas, land segments, and marine mammal species affected by the assumed oil spill. Areas with a combined probability (expressed as percent chance) >5 percent will be assumed as oiled. These areas are outer Kamishak Bay (ERA 4) and Tuxedni Bay (ERA 1). The combined probability range for these environmental resource areas (expressed as percent chance) is 6 to 8 percent.

The conditional probability analysis is based on spill probabilities for transportation routes. The actual spill point will be moved around the sale area to evaluate effects to each marine mammal species from a hypothetical spill of 50,000 bbl. Environmental resource areas with a conditional probability (expressed as percent chance) >5 percent will be assumed as oiled. For each transportation route, all environmental resource areas, land segments, and sea segments with a conditional probability (expressed as percent chance) >5 percent, including the potentially affected marine mammal species, appear in Table IV.B.1.e-2.

Sale-Specific Mortality Factor (SF): A simple model using mortality rates derived from EVOS studies, and adjusted by the proportional difference in the assumed spill size relative to the EVOS size, was developed to estimate potential spill-related mortality.

The spill size assumed for this analysis is 50,000 bbl, or roughly one-fifth the size of the estimated 240,000-bbl EVOS. The large difference in size between these two spills prevents direct usage of EVOS mortality rates to estimate effects for this analysis. Thus, potential mortality will be estimated using EVOS data, but adjusting for spill size as follows:

$M = N(M_E)(SF)$ where
M = Estimated number of individual mortalities
N = Estimated number of individuals contacted or in the affected area
M_E = Species-specific EVOS mortality rates
SF = Sale-specific mortality factor = $50{,}000/240{,}000 = .21$

Example:
$N = 2{,}000$ sea otters
M_E = 42 percent of sea otters in the area estimated killed
$SF = .20$ then
$M = N(M_E)(SF)$, $M = (2{,}000)(.42)(.21)$
$M = 176$ estimated sea otter mortalities in the example

Scaling the EVOS mortality rates by the SF assumes that (holding all other factors equal) there is a relationship between quantity of oil spilled and likelihood of severe environmental damage and marine mammal mortality due to oil contact. The more oil released into the environment (1) the larger the oil slick; (2) the likelihood of contact to individual marine mammals would increase; and (3) the more likely oil would persist to contaminate and recontaminate individuals and habitat. A large oil slick could prevent marine mammals from avoiding oil by forcing transit through it due to sheer spill size. Thus, the proportional difference in spill size was used to generate an estimate of spill-related mortality. These estimates are approximations and are not expected to be as precise as they appear.

(c) Effects on Pinnipeds:

1) **Northern Fur Seal:** Fur seals do not congregate in large numbers in the lower Cook Inlet, so if one or more ≥1,000-bbl spills occurred and contacted the environmental resource areas and land segments indicated by the combined probabilities (see above), perhaps 100 fur seals may become oiled. Using the harbor seal and sea otter mortality estimates from the EVOS and applying the SF yields six to nine fur seal mortalities. This level of mortality would not have a population-level effect for fur seals.

Fur seal numbers are highest in the vicinity of the sale area in May, particularly in Gulf of Alaska waters adjacent to the Portlock and Albatross Banks (ERA's 20, 23, and 25). For fur seals, sale-specific oil-spill effects probably would be most extreme under hypothetical tanker-spill scenario T6 for the Gulf of Alaska (see Table IV.B.1.e-2 for affected resources).

Fur seals around the Albatross Banks in May represent most age-classes; adults and subadults transiting the gulf enroute to the Pribilof Islands breeding grounds and also nonbreeding seals. The seals forage along the Portlock and Albatross Banks and are susceptible to oil contamination by scenario T6. The primary concern with fur seals would be oil contacting their fur, reducing its insulative value and effectiveness as a thermal barrier. There is no way to know the number of fur seals that may be present around the banks in the event of a spill, but groups of

Table IV.B.1.e-2
Conditional Probability (Expressed as Percent Chance) of Oil from Transportation Segments Contacting Environmental Resource Areas Sea Segments, and Land Segments and Potentially Affected Marine Mammal Species

	Transportation Segments																										Potentially Affected Marine Mammal Species (The potentially affected marine mammal species for the resources are included with the understanding that marine mammals are mobile and could occur in other resource areas.)
	Tanker Segments																Pipeline Segments										
	T1		T2		T3		T4		T5		T6		T7		T8		P1		P2		P3		P4		P5		
	Number of Days																Number of Days										
	3	30	3	30	3	30	3	30	3	30	3	30	3	30	3	30	3	30	3	30	3	30	3	30	3	30	
ENVIRONMENTAL RESOURCE AREAS																											
1	>25		>25	>25													>25	>25	>5	>25		>5					harbor seal/beluga whale
2			>5	>5													>5	>5	>5	>5		>5					harbor seal/beluga whale
3			>25	>25	>25	>25	>5	>5		>5									>5	>5	>5	>25		>5			sea otter/ harbor seal/beluga whale/ Minke whale
4					>5	>25	>5	>25		>5								>5	>5	>25	>25	>25	>25	>25			sea otter/harbor seal/beluga whale/ Minke whale
5					>5	>5		>5		>5										>5	>5	>5	>5	>25			sea otter/harbor seal/beluga whale
6					>5	>5	>90	>90	>25	>25		>5		>5								>5		>5	>5	>5	sea otter/harbor seal/Minke whale/ killer whale/Dall's porpoise/ harbor porpoise
7					>5	>5	>5	>25		>5												>5	>25	>25	>25	>25	sea otter/harbor seal/Minke whale/ killer whale/all's porpoise/ harbor porpoise/fur seal
8								>5	>5	>5		>5		>5											>5	>5	sea otter/harbor seal/Minke whale/ killer whale/Dall's porpoise/ harbor porpoise/fur seal
9						>5		>5														>5		>5	>5	>25	sea otter/Minke whale/killer whale/ Dall's porpoise/harbor porpoise/ fur seal
10																										>5	sea otter/Minke whale/killer whale/ Dall's porpoise/harbor porpoise/ fur seal
11																										>5	sea otter/harbor seal/Minke whale/ killer whale/Dall's porpoise/ harbor porpoise/fur seal
12																										>5	Minke whale/killer whale/Dall's porpoise/harbor porpoise/fur seal
13																											harbor sea/Minke whale/killer whale/Dall's porpoise/ harbor porpoise/fur seal
20												>5		>5													Minke whale/killer whale/Dall's porpoise/harbor porpoise/fur seal/ Pacific white-sided dolphin
21										>5		>5		>5													harbor seal/Minke whale/killer whale/harbor porpoise
22																											harbor seal/Minke whale/killer whale/harbor porpoise
23										>5		>5		>5		>5											Minke whale/killer whale/Dall's porpoise/harbor porpoise/fur seal/ Pacific white-sided dolphin
24										>5		>5		>5		>5											Minke whale/killer whale/Dall's porpoise/harbor porpoise/fur seal/ Pacific white-sided dolphin
25									>5	>25	>90	>90	>25	>25		>25											Minke whale/killer whale/Dall's porpoise/harbor porpoise/fur seal/ Pacific white-sided dolphin
26										>5		>5															sea otter/harbor seal/Minke whale/ killer whale/harbor porpoise
SEA SEGMENTS																											
1	>5																										harbor seal/beluga whale
2	>25		>5	>5													>5	>25		>5							harbor seal/beluga whale
3																										>5	sea otter/harbor seal/Minke whale/ killer whale/Dall's porpoise/harbor porpoise/fur seal
4												>5		>5		>5											sea otter/harbor seal/Minke whale/ killer whale/Dall's porpoise/ harbor porpoise/fur seal
LAND SEGMENTS																											
28				>5		>5																				>5	sea otter/ harbor seal/beluga whale
29				>5		>5												>5		>5		>5					sea otter/ harbor seal/beluga whale
35	>5			>5														>5									harbor seal/beluga whale
38	>5																										harbor seal/beluga whale
39	>5																										harbor seal/beluga whale
40	>5																										harbor seal/beluga whale
41																											harbor seal/beluga whale
42			>5	>5														>5									harbor seal/beluga whale
46							>5	>5																			sea otter/harbor seal/beluga whale
74																										>5	sea otter/harbor seal
75										>5																	sea otter/harbor seal
76										>5																>5	sea otter/harbor seal

more than 100 have been observed throughout the gulf during their migration. Estimated fur seal numbers around the banks at a given time in May probably are 1,000 to 3,000 seals.

It is difficult to estimate fur seal mortality under any spill scenario, because there never has been a major oil spill near concentrations of northern fur seals. After the EVOS, it was estimated that 42 percent of PWS sea otters were killed (comparing prespill to postspill population estimates; Garrott, Eberhardt, and Burn, 1993); and observed decreases of 31 percent were noted for harbor seals at oiled trend sites. Fur seals are similar to sea otters in that they rely on their fur for thermoregulation; but because they are pinnipeds, fur seals are closer to harbor seals physiologically and in other important life-history characteristics. Using the sea otter mortality estimate from the EVOS and applying the SF yields:

N = 3,000 fur seals
M_E (sea otters) = 42 percent of sea otters in the area estimated killed
$SF = .20$ then
$M_1 = N(M_E)(SF)$, $M_1 = (3{,}000)(.42)(.21)$
M_1 = 264 estimated fur seal mortalities.

Using the harbor seal mortality estimate from the EVOS (31% or .31) and applying the SF yields 195 estimated fur seal mortalities.

The latest population estimate for the Pribilof Islands fur seal population is 982,000 (Antonelis, 1993, personal comm.); and the estimated natural mortality of Pribilof Islands fur seals is 16 percent for females and 29 percent for males (Reed et al., 1987). The level of spill mortality (186-252) from spill T6 is only 0.03 percent of the population and would not be expected to have a population-level effect on fur seals.

2) **Pacific Harbor Seal:** Harbor seals are present in the nearshore throughout the sale area. A large spill in the sale area may contact harbor seals or harbor seal habitat. For harbor seals, sale-specific oil-spill effects probably will be most extreme under hypothetical tanker spill scenario T5 for lower Cook Inlet during the late summer/early fall molting period (see Table IV.B.1.e-2 for affected resources). An observed decrease of 31 percent was noted for harbor seals at oiled trend sites in PWS 3 years after the spill. A recent maximum count for Kachemak Bay (ERA 3) is 522 seals, about 1,441 seals for outer and inner Kamishak Bay (ERA's 4 and 5, including Augustine Island), 52 seals for the Barren Islands (ERA 6), 76 seals for Shuyak Island (ERA 8), 272 seals for Ugak Bay and Ugak Island (ERA 21), and 273 from West Nuka Island to McCarty Fiord (ERA 26) for a total of 2,636 seals in the affected area (Loughlin, 1992). If these sites are assumed oiled, using the harbor seal mortality estimate from these sites are assumed oiled, then by using the harbor seal mortality estimate from the EVOS and applying the SF yields 171 harbor seal mortalities.

If the spill occurred and contacted these environmental resource areas as indicated by the combined prob- abilities, Tuxedni Bay and outer Kamishak Bay could be affected. Recent maximum counts for Tuxedni Bay (ERA 1) and outer Kamishak Bay (ERA 4, including Augustine Island) are 972 seals (Loughlin, 1992). Using the harbor seal mortality estimate from the EVOS and applying the SF yields 63 harbor seal mortalities. The effect of such mortality (63 seals) on the seal population of lower Cook Inlet is difficult to estimate, because Cook Inlet seal numbers have decreased about 50 percent in the last 13 years for unknown reasons. It is unlikely that all seal habitat and seals in the affected area would become oiled, so this estimate probably is high. Oil-spill-related mortality probably would have a minimal and relatively short-term effect on the local harbor seal population.

(d) Effects on Cetaceans:

1) **Eastern North Pacific Gray Whale:** If gray whale secondary-migration-route areas (lower Cook Inlet/Shelikof Strait) are contaminated by an oil spill when whales are present, potential outcomes include avoidance of oiled areas, skin contact with oil, baleen fouling, membrane irritation or ulceration, and respiratory distress caused by inhalation of hydrocarbon vapors. Because these areas are used by <1 percent of the eastern Pacific population, only small numbers of individuals potentially could be contacted by a spill. Although the occurrence probability of one or more tanker spills ≥1,000 bbl is just 6 percent, if one occurred outside the entrance to the lower Cook Inlet/ Shelikof Strait area along tanker segments T5 to T8, it could contact portions of the primary migration corridor traveled by gray whales east of Kodiak Island. Even in this situation, a relatively small proportion of the population would be expected to encounter oil due to the extended gray whale

migration period (passage of the migratory population occurs over 2-3 months) and likely rapid dispersal of oil in Gulf of Alaska waters; as in the proposed sale area, no mortality would be expected to result from this scenario. In view of the low numbers of individuals potentially affected and relatively minor effects on individuals, overall effect of development and production on gray whales is expected to be minimal.

2) **Minke Whale**: Minke whales are abundant in the Gulf of Alaska during spring/summer and, in the sale area, are found mostly in continental shelf waters <200-m deep. The hypothetical spill scenario from transportation segment T6 (see Table IV.B.1.e-2 for affected resources) would be most likely to contact minke whales in the continental shelf waters between eastern Kodiak Island and the Portlock and Albatross Banks (ERA's 20, 23, and 25). Little data exist on spill effects to baleen whales; however, the observational data that do exist suggest minimal effects. Humpback and fin whales were observed feeding in a slick created by the *Regal Sword* oil spill (Goodale, Hyman, and Winn, 1981). Right whales and tentatively identified minke whales also were observed swimming in the same spill, but not feeding. No attraction or repulsion to the oil was noted, with no difference in whale behavior in or outside the oil slick. Humpback whales did not seem affected by the EVOS, unless decreased usage of lower Knight Island Passage during 1989 was due to a spill-related effect. In any event, humpbacks returned to the area in 1990. Two minke whale carcasses were found during the summer of 1989, but they did not appear to represent spill-related mortality (Loughlin, 1993a and b, personal comm.). Minke whales probably would not be affected by an oil spill from segment T6; if they were, the effect probably would be displacement until the spill and spill-related activity dissipates.

3) **Killer Whale**: Killer whales can occur throughout Cook Inlet, but usually in small pods of up to five individuals. As predators, they frequent areas with a high concentration of potential prey. In Cook Inlet, such areas are near river mouths where they intercept returning salmon and/or feed on beluga whales feeding on anadromous fishes. Because of the small number of killer whales found and their low frequency of occurrence in Cook Inlet, it is unlikely they would be affected by a spill event affecting the resource areas (Tuxedni Bay and outer Kamishak Bay) contacted under the combined probabilities.

Portlock and Albatross Banks (ERA's 20, 23, and 25) are areas of high productivity; and pinnipeds, small and large cetaceans, and many fish species feed on and around the banks. Thus, killer whales probably also frequent the area and may be contacted by a hypothetical spill from transportation segment T6 (see Table IV.B.1.e-2 for affected resources).

One pod of killer whales was observed swimming in the slick created by the EVOS. However, no dead killer whales were observed in association with the EVOS, so mortality could not be directly measured. Estimated mortality for the AB pod in 1989 was 19.4 percent, up from 3 to 4 percent in other years (Matkin et al., 1993), but the evidence of this elevated mortality is circumstantial. Nonetheless, as much as 15-percent mortality in the AB pod during 1989 may have been due to the EVOS. The largest aggregation of killer whales in the western Gulf of Alaska in 1992 was 81, although the mode for sightings was 4 (Dahlheim and Waite, 1993). Using the EVOS mortality rate for the AB pod from 1989 to 1992 and adjusting with the SF yields five estimated killer whale mortalities.

Recruitment rates for the AB pod ranged from 13.8 percent in 1988, 4.5 percent in 1991, to 9.1 percent in 1992, with no recruits in 1989 or 1990, for an average annual rate of 5.48 percent over the 5 years. Using the 5.48-percent- annual recruitment rate, the population affected by the segment T6 spill would recover to prespill numbers in about 1 to 2 years, although pod age and social structure may take longer.

4) **Beluga Whale**: Beluga whales are common in Cook Inlet and generally frequent shallow nearshore waters, bays, and estuaries. The hypothetical spill scenario most likely to contact belugas would be transportation segment T1 (see Table IV.B.1.e-2 for affected resources). Recently, 242 belugas have been counted in Cook Inlet on a single day, providing an estimate of 653 animals in the inlet population after the correction factor is applied. (A National Marine Fisheries Service [NMFS] unpublished report currently estimates the population at 898.) There are no data on the effects of oil on beluga whales in the wild. Furthermore, little is known about the Cook Inlet beluga population in terms of recruitment or mortality rates. Belugas tend to travel in groups and are medium-size toothed whales; both are characteristics shared with killer whales. One method of estimating potential beluga whale mortality from a hypothetical spill is to use killer whale data from the EVOS and apply the SF. This results in 43 estimated beluga whale mortalities. There also are several other considerations. During a portion of the year, most of the whales are likely to be found in the upper portion of

Cook Inlet and would not be affected by an oil spill in lower Cook Inlet. The OSRA estimates a <5-percent chance that one or more spills ≥1,000 bbl would occur and contact SS1 (near the Forelands) or many of the areas where beluga whales might occur. As a result, it is likely that <43 belugas would be killed.

Because there are no good estimates of Cook Inlet beluga recruitment rates, they will be estimated using the NMFS (USDOC, NOAA, NMFS, 1991) general estimate for cetacean maximum net productivity (MNPL = 2%) X a recovery factor (.5) based on the status of the stock. For Cook Inlet belugas, a conservative population size is 600 individuals postspill, so 600(.02) (.5) = 6 individuals per year would be recruited into the population. Recovery to prespill numbers for Cook Inlet belugas would take about 7 years, although group age and social structure may take longer to recover.

The estimated mortality based on the combined probabilities does not change, because the effects are estimated considering a very large number of the Cook Inlet population. These whales could be present anywhere in Cook Inlet during the summer season, including the environmental resource areas determined by both combined and conditional probabilities where probability of spill contact is >5 percent.

5) **Dall's Porpoise and Pacific White-Sided Dolphin:** Both the Dall's porpoise and the Pacific white-sided dolphin are present in highest numbers in the Gulf of Alaska during the spring/summer season. Dall's porpoises can be found in lower Cook Inlet and in the Gulf of Alaska, usually in groups of 2 to 20 individuals. The highest aggregations are likely to occur around food-concentration areas (e.g., the Portlock and Albatross Banks). Pacific white-sided dolphins also frequent the banks but in larger schools of over 100 individuals. They are less likely to be found up inside Cook Inlet but could occur near the entrance. The hypothetical spill scenario that may contact both species is the segment T6 spill (see Table IV.B.1.e-2 for affected resources). There is some evidence that spill effects on these species would be minimal. There was no mortality of Dall's porpoises or Pacific-white sided dolphins observed during or after the EVOS, although the spill occurred in Dall's porpoise habitat and passed though the northern Gulf of Alaska in Pacific white-sided dolphin habitat. Although a large amount of scientific research was conducted in the area at the time and provided an opportunity to detect disoriented, sickly, or dead animals, it is possible that effects did occur but went undetected. Both of these species are fast swimming and highly mobile, so it is possible that they can detect and avoid spilled oil. Interestingly, Atlantic white-sided dolphins were observed swimming and foraging in an oil slick caused by the *Regal Sword*, with no apparent ill effects (Goodale, Hyman, and Winn, 1981).

6) **Harbor Porpoise:** Harbor porpoises inhabit the nearshore waters throughout the sale area; they are present in largest numbers in the Shelikof Strait (Dahlheim et al., 1993). One hypothetical spill scenario that may contact harbor porpoises is segment T3 in lower Cook Inlet adjacent to Kachemak Bay (see Table IV.B.1.e-2 for affected resources). However, it is likely that spill effects would be minimal as with the closely related Dall's porpoise. Harbor porpoises usually are sighted singly or in pairs, so the risk of a spill contacting large numbers of them is small. Furthermore, as with Dall's porpoises, no mortality from the EVOS was observed with harbor porpoise.

(e) **Effects on the Sea Otter:** The hypothetical spill scenario that might pose the most risk to sea otters would be transportation segment T4. Sea otter high-use areas from Kamishak and Kachemak Bays and south to Hallo/Kukak Bays on the western side of Shelikof Strait and the Barren and Shuyak Islands would be affected. About 4,000 sea otters reside in these resource areas, so mortality rates from a hypothetical spill may be estimated using data from the EVOS and applying the SF results in 353 estimated sea otter mortalities. Recovery to prespill numbers could take 1 to 2 years at a 5- to 10-percent annual rate of increase (Eberhardt and Siniff, 1988).

Using combined probabilities, only sea otters from outer Kamishak Bay (ERA 4) would be affected by a spill for a total of about 1,000 sea otters. So, using data from the EVOS and applying the SF results in mortality estimated at 88 sea otters. This level of mortality would take about 1 to 2 years for recovery of lower Cook Inlet sea otters.

(4) **Indirect Effects of Oil on Marine Mammals:** Indirect effects of oil spills or oil pollution on marine mammals include changes in food supply, consumption of prey species that have bioaccumulated PHC's, and the bioaccumulation of PHC's in the tissues of individual animals.

Reductions of marine mammal prey as a direct result of a spill event could occur; but it has been extremely difficult to quantify spill effects on marine mammal prey populations or to differentiate spill effects on prey numbers from their natural variability. As a result, the indirect effect of reduced or altered prey availability has not been shown to have had an effect on marine mammals in any of the past oil spills.

Certain species of marine mammal prey bioaccumulate oil (incorporate it into their body tissues). Some crustaceans and fish can bioaccumulate 200 to 300 times the PHC content of ambient water but eventually discharge the PHC's when placed in clean water (Varanasi and Malins, 1977). Studies have shown that bioaccumulated PHC's do not biomagnify (increase in concentration) through the food web (Eisler, 1987), and that was the case across lower trophic levels (mussels, periwinkles, drills, and sea stars) after the EVOS (Lees et al., 1991).

Although marine mammals could consume oil-contaminated prey and do retain some PHC's in certain body tissues, it is unclear what the effects of bioaccumulation would be. Studies attempting to determine the effects of sea otter consumption of contaminated prey following the EVOS have been inconclusive (Ballachey, 1993, personal comm.).

Some marine mammal species have higher body burdens of PHC's than others. For example, a variety of marine mammals were analyzed for traces of PHC's (napthalene). Although the study had limitations, some trends were evident. Nearshore species—the harbor porpoise and harbor seal—had higher levels of blubber-bound napthalene than was found in more offshore baleen whales (Geraci and St. Aubin, 1982). Also, beluga whales and narwhals had the highest levels detected in the study—and both species reside in cold water that retards PHC metabolism in some fish species (Collier, Thomas, and Malins, 1985). As marine mammals use these fat reserves, PHC's are mobilized and are once again available for detoxification, excretion, or transfer from mother to young via nursing (Hansen, 1992). It is not clear whether such a release of tissue-bound PHC's would have an effect on the marine mammals. However, because cetaceans and pinnipeds (and probably sea otters) can metabolize and detoxify small quantities of ingested oil (St. Aubin, 1990; Geraci, 1990; Geraci and Williams, 1990), consumption of contaminated prey probably poses less risk to marine mammal populations than the direct effects of oil ingestion described above (sec. 1c).

(5) **Effects of Noise and Disturbance on Marine Mammals:** Noise and disturbance activities that may affect marine mammals in the proposed sale area include geophysical surveys, marine dredging and construction, support vessels, aircraft overflights, and offshore drilling and production. Marine mammal population vulnerability to disturbance depends on (1) the number of animals involved, (2) sensitivity of the species, (3) the presence of preferred habitat in relation to the disturbance, (4) the characteristics of the disturbance source, and (5) the characteristics of the environment (water depth, bottom type, bottom contour, etc.). Comprehensive reviews or study results examining the effects of oil- and gas-related noise and disturbance on marine mammals are available in Hill (1978), Geraci and St. Aubin (1980, 1985), Terhune (1981), Gales (1982), Malme et al. (1989), Johnson et al. (1989), and Richardson et al. (1989, 1990, 1991, 1992). The loudest sources likely to affect marine mammals in the sale area are seismic arrays, large ships, and dredges. Sound levels produced by smaller vessels become important when several are operating in a small area at the same time (Malme et al., 1989).

(a) **Geophysical Noise:** Seismic surveys in open water produce underwater sounds with source levels that exceed those of other oil- and gas-exploration activities (Malme et al., 1989). Airgun arrays commonly used for seismic exploration in open water produce relatively brief and intermittent sounds. Depending on the acoustic environment, these seismic pulses can be detected underwater at distances of 50 km or more from the source (Richardson et al., 1989).

The effect of seismic pulses on pinnipeds has not been directly studied. But information on waterborne sound levels and their effect on pinniped behavior are available from pinniped/fishery interaction studies. Some pinnipeds are known to habituate to strong underwater noises used to deter seals and sea lions from fishing operations (Mate and Harvey, 1986). Underwater sounds generated by seismic surveys (500 hertz [Hz] at up to 170 dB) (Malme et al., 1989) are below the "most sensitive range" for pinnipeds (1-60 kilohertz [kHz]) (Richardson et al., 1991b) and probably would not greatly affect harbor and fur seal activities.

Behavioral observations of sea otters along the central California coast indicate no reaction to seismic noise from either a full array or single airgun (Riedman, 1984). No disturbance reactions were evident, even when the array was towed as close as 0.9 km (Riedman, 1983).

Reactions of baleen whales to seismic noise have been studied directly for several species but not for the minke whale. Effects on the minke whale likely would be similar to effects on gray and humpback whales. Migrating gray whales show avoidance reactions to seismic pulses exceeding 160 dB re 1 micropascal (μPa). Levels at which 10, 50, and 90 percent of the whales reacted were 164, 170, and 180 dB (Malme et al., 1989). These levels were reached at 3.6-, 2.5-, and 1.2-km distances from the source. Humpback whales showed startle response at received sound levels of 150 to 169 dB (Malme et al., 1985). Recovery of bowhead whales to typical surface-respiration-dive characteristics 30 to 60 minutes after disturbance by nearby seismic operations suggests that, to the extent bowhead and gray whale response to disturbance is similar, the effect of such a stimulus typically is brief. Baleen whales apparently are tolerant of seismic pulses and continue normal activities when sound levels are below 150 dB. Subtle behavioral changes may occur on occasion at lower received levels. But stronger avoidance reactions usually occur when sound levels reach 160 to 170 dB, or higher and, depending on the acoustic environment, that usually is several kilometers from the source (Malme et al., 1989). The likelihood of the relatively few gray whales traveling through this secondary migration area intersecting with seismic vessels operating for short periods in limited areas is expected to be low. Consequently, few whales are expected to interact with seismic vessels and any avoidance responses should be brief, lasting an hour or less, and result in minimal effects. Seismic activities are expected in association with exploration; some minke whales are expected to locally avoid the locations of these activities at distances up to 4 km. This avoidance is expected to be relatively short term (only during seismic testing), with the whales resuming normal activity patterns upon cessation of testing.

Generally speaking, toothed-whale sound reception and sensitivity are at high frequencies (Awbrey, Thomas, and Kasletein, 1988), ranging from 31 kHz in killer whales to over 100 kHz in other species (Richardson et al., 1991b). Bottlenose dolphins and beluga whales can hear sounds as low as 40 to 125 Hz, but sensitivity is weak below 10 kHz. Toothed-whale hearing appears poor at frequencies lower than 1 kHz, where most industrial sounds and seismic pulses are produced (Richardson et al., 1991). Thus, effects on toothed-whale species should be less than effects on baleen whales—either no reaction or short-term avoidance by individuals in the vicinity of the source.

(b) <u>Marine Construction</u>: Offshore and nearshore construction could occur in this scenario. Underwater noise produced by this activity was studied only in the Arctic (Richardson et al., 1991b), so the sounds referred to in the following discussion may be different in this sale area. Beluga and bowhead whales sometimes approached as close as 400 and 800 m, respectively, to an operating dredge in the Beaufort Sea (Richardson et al., 1990b, 1991b). During playback studies of dredging noise, some bowhead whales behaved normally while others exhibited avoidance reactions. During non-oil- and gas-related industrial activity in Mexican waters, gray whales abandoned Laguna Guerrero Negro, Baja California, possibly due to dredging activity necessary to maintain the channel for shipping. Gray whales reoccupied the lagoon when the activity ceased (Bryant, Lafferty, and Lafferty, 1984). These observations indicate that cetaceans may react to dredging and construction activities by avoidance of the disturbed area during construction, but they probably would reoccupy the disturbed area upon project completion.

There are no direct studies of harbor and fur seal reaction to waterborne noise due to oil- and gas-industry-related dredging and construction. But harbor seals in Kachemak Bay continued to haul out during construction of hydroelectric facilities 1.6 km away (Malme et al., 1989). Also, fur seals showed little reaction to heavy-equipment operation 100 m distant and blasting at 300 m during construction activity in a rock quarry on St. George Island (Gentry, Gentry, and Gilman, 1990). Thus, effects from dredging on pinnipeds likely would range from no reaction to temporary displacement.

(c) <u>Support and Transport Vessels</u>: Support vessels include tugboats, workboats, and other vessels used to service and supply offshore worksites. There could be as many as 45 trips per month by support vessels servicing offshore platforms. These vessels usually are 12 to 30 m long; and the primary noise and disturbance source is the propeller noise, about 37 to 1,000 Hz at up to 170 dB (Richardson et al., 1991). Smaller outboard-motor noise is at a higher frequency at up to 10 kHz. Sounds created by commercial vessels and supertankers used to transport crude oil range from about 7 to 430 Hz at up to 190 dB re 1 μPa at 1 m (Richardson et al., 1991).

Marine mammal reactions to marine-vessel traffic have not been particularly well studied, yet there are many observational records, mostly regarding cetaceans. Pinnipeds react to vessels differently depending on the species involved and whether the animals are in the water or on land. Hauled-out harbor seals may respond to an approaching vessel by entering the water when the vessel is 150- to 200-m distant (Burns, as cited in Johnson et al., 1989) but may pay no attention to vessels >200-m away. Fur seals at sea can be curious and approach research vessels; but sleeping fur seals awakened by an approaching ship rapidly departed when the ship was 1 mi away (Kajimura, as cited in Johnson et al., 1989). Steller and California sea lions hauled out near major shipping lanes were not disturbed by vessel traffic (Bigg, as cited in Johnson et al., 1989), and sea lions are well known to congregate around and follow sport- and commercial-fishing vessels. These observations indicate that pinnipeds generally are undisturbed by vessel traffic. Exceptions would include close approach to certain species, such as harbor seals, when hauled out. Generally, this type of disturbance would be short term; and the seals would return after the disturbance ended. But repeated disturbance of harbor seals may cause them to abandon a preferred haulout location, and this could negatively affect those individuals.

Sea otters commonly allow close vessel approach but avoid areas of major disturbance (Richardson et al., 1991). They may avoid areas of frequent vessel traffic then reoccupy those areas during seasons of less frequent activity (Garshelis and Garshelis, 1984).

There is no clear pattern of cetacean reactions to vessel-generated noise and vessel activity. Reactions of beluga whales to industrial-vessel activity in the Canadian Arctic were studied and are quite variable. Belugas sometimes avoid tugboats and supply vessels and respond at up to 2.4 km away from the vessel and on other occasions approach as close as 0.2 km (Fraker, 1977, 1978). It appears that belugas are more sensitive to vessel traffic when sea ice is present (Richardson et al., 1991b). They appear more responsive to outboard-motor noise than to other vessel noise, perhaps because they are hunted from vessels powered by outboard motors. In Cook Inlet, belugas occur commonly in the presence of large-vessel and small-boat traffic (Burns and Seaman, 1985, as cited in Richardson et al., 1991b).

Harbor porpoises tend to avoid vessels at distances of 1 km (Barlow, 1988), with stronger avoidance within 400 m (Polacheck and Thorpe, 1990). Dall's porpoises commonly approach ships and small vessels to ride the bow pressure wave. Clearly, of these three cetaceans that commonly occur in Cook Inlet, the harbor porpoise is the most likely to avoid routine vessel traffic due to lease activities.

There are many accounts that describe baleen whale reactions to marine vessels. Watkins (1986) reviewed whale reactions to vessel traffic and whale watching near Cape Cod and found that each species reacted differently. Sudden changes in sound levels—rapidly changing vessel noise due to changing speed or approaching the whales—would cause a whale response. Vessels that approach no closer than several kilometers are not expected to disturb the whales, and avoidance of vessels by gray whales is expected to occur only when separation is ≤550 m (Bogoslovskaya, Votrogov, and Semenova, 1981). Vessels that maintain a constant speed and course probably will cause little disturbance of gray whales. In the most-likely scenario, a small number of whales traveling in the vicinity of a drilling-unit-supply route could be exposed to a vessel, causing them to dive or divert their direction of travel briefly. However, because only one supply-vessel trip per day is anticipated (Table IV.A.1-1), travel routes followed by the few gray whales likely to traverse this secondary-migration area are expected to intersect those of vessels infrequently, and thus interactions are expected to be few, responses brief (a few minutes to tens of minutes), and effects minimal. Gray whales may exhibit minor avoidance response if their travel path takes them within 300 m of a tanker during the whale migration; but only a small proportion of the population is expected to be affected, with detectable effects lasting less than an hour. Minke whale behavior appeared to change from attraction in the early years to general lack of interest, with few negative reactions (Watkins, 1986).

In summary, baleen whales often ignore distant low-level sounds, such as those generated by vessels, but in certain situations may approach them. Whales appear to habituate to vessel activity through time but may interrupt normal behavior in response to rapidly changing vessel noise (Richardson et al., 1991). These observations suggest cetaceans would not be affected by increased vessel traffic in the sale area due to the proposed sale activities. Some whales may alter their swimming direction or move away from a particular vessel but, through time, likely would habituate to routine vessel traffic and noise.

(d) Aircraft Overflights: Aircraft overflights (primarily helicopter traffic, about 60 trips/month) in support of exploration activities are expected to occur. Marine mammal response to aircraft overflights depends primarily on the loudness of the source. Some species are more sensitive to disturbance than others, and there are time periods when disturbance effects are more pronounced and potentially deleterious to the animals.

Pinnipeds hauled out during the molt or pupping seasons are most sensitive to aircraft disturbance. Harbor seals typically flee into the water in response to low-flying aircraft. During such a disturbance, mother-pup separation can occur and lead to increased pup mortality. Aircraft flying below 400 ft nearly always cause seals to vacate the beach (Johnson et al., 1989). Response was variable to overflights between 400 and 1,000 ft and depended on weather, frequency of disturbance, altitude, and aircraft type. Northern fur seals will stampede into the water from haulouts or rookeries in response to low-altitude overflights. They did not react visibly to overflights of single-engine, fixed-wing aircraft at 300 to 500 ft but stampeded into the water in response to a large twin-engine aircraft flown at the same altitude (Swibold, 1988; Antonelis, 1988, as cited in Johnson et al., 1989).

Just as with other noise and disturbance sources, cetaceans react variably in response to aircraft overflights. Sensitivity to such disturbance seems to depend on the activity and the circumstances for individual whales (Malme et al., 1989). Generally, cetaceans dive in response to close overflights.

Beluga whales may react to aircraft noise at 150 to 200 m but not at 500 m (Bel'kovitch, 1960; Kleinenberg et al., 1964, as cited in Richardson et al., 1991). Belugas dove in response to helicopter overflight at 305 m (Sergeant and Hoek, 1988). Feeding belugas were less easily disturbed than swimming whales, and there was no reaction at altitudes of 150 to 200 m (Fraker and Fraker, 1979, as cited in Richardson et al., 1991).

For baleen whale reactions to aircraft overflights, data exist for bowhead and gray whales. Bowheads react frequently at altitudes of <305 m, react infrequently at 457 m, and react rarely above 610 m (Richardson et al., 1985). Even though bowheads respond to aircraft overflight, the disturbance is short term. Bowheads repeatedly photographed and identified from low-altitude aircraft over a period of days to weeks were not displaced from a feeding area (Richardson et al., 1991b). Mating gray whales did not react to survey aircraft flown at 320 m (Ljungblad et al., 1987) but did respond to playback of helicopter noise recorded underwater. In fact, 50 percent of the whales exhibited avoidance when the received-noise level reached 120 dB re 1 μPa (Malme et al., 1984). In the most-likely scenario, a small number of whales traveling in the vicinity of a drilling-unit-supply route could be exposed to an aircraft, causing them to dive or divert their direction of travel briefly. However, because only two helicopter-supply trips per day are anticipated (Table IV.A.1-1), travel routes followed by the few whales likely to traverse this secondary migration area are expected to intersect those of vessels or aircraft infrequently, and thus interactions are expected to be few, responses brief (a few minutes to tens of minutes), and effects minimal.

In summary, pinniped response to low-altitude aircraft can result in stampede or flight into the water, which, if it occurred, might increase pup mortality during the pupping season. Both baleen and toothed whales usually respond to low overflights by diving. Reactions of pinnipeds and cetaceans vary by aircraft type, altitude of flight, and circumstances of the animals. Aircraft overflights (primarily helicopter traffic) in support of exploration activities are expected to occur. In-place mitigating measures restrict aircraft activity from direct overflights of marine mammals, and impose minimum altitude requirements of 1,500 ft. If these measures are observed, the aircraft overflights should have minimal effects on marine mammals, most likely limited to short-term disturbance reactions, with seals reoccupying haulouts and whales continuing their activities usually within a matter of hours.

(e) Drilling and Production: Marine mammal reaction to drilling and production noise has been documented by both anecdotal accounts and through controlled studies. Responses by cetaceans provide the bulk of information, with relatively few examples of sea otter and pinniped reactions in the literature.

Though pinniped reactions to drilling and production noise have not been directly studied, McCarty (1982) found that California sea lions were commonly associated with drilling platforms off Santa Barbara, California; and northern sea lions were observed near platforms in Cook Inlet, Alaska. Pinnipeds potentially affected by drilling noise in the sale area are fur and harbor seals. These seals probably would respond to drilling noise similarly as California and northern sea lions do and would be relatively unaffected.

Sea otters observed during playback of drilling and production noise did not deviate from normal behavior (Reidman, 1983, 1984). Sea otters continued to forage while exposed to noise sources 400 to 1,200 m away. At 1,200 m, the noise source was still 10 dB above ambient, or higher (Malme et al., 1983, 1984).

Cetacean reactions to drilling and production noise are much better studied. Underwater-drilling noise produced by a grounded ice platform was played back to migrating beluga whales in the spring-lead system off Barrow, Alaska (Richardson et al., 1990, 1991). The sounds were mainly low frequency, below 350 Hz. Although the sound could be detected by hydrophones up to 5 km away, the whales did not react until they were within 200 to 400 m, where some hesitated while others continued on to within 50 to 200 m. Response was variable to playback of drilling sounds from a semisubmersible projected into a river (Stewart, Awbrey, and Evans, 1983). Some exposed whales increased swimming speed and respiration rates. Reaction was not noticeable until the whales were within 50 to 75 m in one test and 300 to 500 m in another. Though the whales did react, most swam past the sound source (Stewart, Awbrey, and Evans, 1983). Anecdotal accounts of beluga whales in Cook Inlet indicate either no reaction to drilling platforms or the whales easily avoided them (McCarty, 1982).

Gray, bowhead, and humpback whale responses to drilling noise have been studied by playback of underwater-drilling noise. Off California, gray whales respond to the sounds by reducing swimming speed and deflecting their migration path to avoid the sound source (Malme et al., 1983, 1984). Reaction varied with the type of drilling noise. The range at which 50 percent of the whales may respond was 1,100 m for the drillship noise and 4 to 20 m for the platforms and semisubmersible. Actual sound levels measured at 100 m were highest for the drillship, at 136 dB re 1 μPa (Malme et al., 1984). If located in an area traversed by gray whales during migration, drilling operations could cause a few whales to divert their direction of travel for an hour or less, resulting in displacements of several hundred meters to a few kilometers from the site (Malme et al., 1984). Such displacement is expected to have a minimal effect, because it is likely to involve <1 percent of the eastern Pacific population temporarily avoiding an extremely small portion of a secondary migration route (lower Cook Inlet/Shelikof Strait) during both exploration and development and production.

Similar playback to bowhead whales showed reaction to noise levels near 94 to 118 dB re 1 μPa (Richardson et al., 1985). In another study, the only strong reaction was to noise near 120 dB (Wartzok et al., 1989). Variability in observed response may have been due to habituation or individual whale sensitivity. Some evidence indicates that migratory bowhead whales may be more sensitive to noise disturbance than summering bowheads (Richardson et al., 1991b). Humpback whale response data are limited to few observations but indicate no definite avoidance behavior at noise levels up to 116 dB re 1 μPa (Malme et al., 1985).

Cetaceans often are observed within a radius of where drilling noise is audible. Reactions to drilling are limited to short-term changes in travel direction to avoid the sound source and short-term increases or decreases in swimming speeds.

Both minke and beluga whales have been observed in the vicinity of platforms in the inlet with no apparent deleterious effect (McCarty, 1982). Based on the information presented above, both species temporarily might avoid drilling operations but likely would habituate to drilling operations after some time.

(6) Effects of Habitat Loss and/or Alteration on Marine Mammals: Habitat loss or alteration would be limited to temporary disturbance to some sea otters and harbor seals in the nearshore environment associated with construction of pipeline and transport facilities. Such activities may cause harbor seals and sea otters to haul out and forage in less-suitable habitat or different areas. This disturbance likely would be relatively short term and very localized, and should not affect survival.

Water-Quality Drilling Discharges: Water-quality information for the sale area is summarized in Section III.A.5, and effects on water quality in Section IV.B.1.a (base case). Recent studies in Cook Inlet indicate relatively low levels of measured hydrocarbons in sea water, seafloor sediments, and marine-organism tissues (UAA, ENRI, 1993; Hyland, Sauer, and Tate, 1993). The levels of hydrocarbons detected were characteristic of uncontaminated coastal and offshore environments, well below levels that could cause adverse biological effects (Hyland, Sauer, and Tate, 1993). Also, another study in the vicinity of Trading Bay examining the potential effects of a produced water outfall on the marine environment of upper Cook Inlet, indicated PHC's were uniformly very low (and below the Alaska Standards) in the water column and in nearby depositional sediments (Neff and Douglas, 1994). Detected levels of PHC's were orders of magnitude lower than concentrations that could be harmful to marine life in upper Cook Inlet. Thus, the tidal flux and flushing rate of Cook Inlet have worked to keep the inlet relatively free of contaminants that may affect water quality. Drilling discharges added to the sale area by postlease activities may contribute additional heavy metals but are not expected to significantly affect water quality and have an effect on marine mammals. Contaminants associated with drilling muds have limited availability for bioaccumulation by the benthic marine organisms eaten by gray whales, should any whales feed in the limited area likely to be contaminated by the discharge (Neff, 1987; NRC, 1985). Burial of benthic prey by muds and cuttings discharged at a drill site or interference of such discharges with any foraging whale's ability to locate prey is expected to involve such a restricted area that there would be no adverse effect. Most gray whales are not expected to be foraging while in this area.

<u>Summary</u>: The potential physiological and behavioral effects of oil contact, inhalation, and ingestion were reviewed for nonendangered marine mammals in the sale area. Mortality rates derived from the EVOS and adjusted by the SF were used to estimate potentially lethal effects of an oil spill on each species. Sale-specific oil-spill effects were determined to cause the mortality of <10 fur seals and killer whales, respectively; approximately 43 beluga whales; approximately 63 harbor seals; and between 75 to 100 sea otters. Recovery to prespill numbers was estimated to occur in about 1 to 2 years, with recovery of belugas to prespill numbers estimated at 7 years. It may take longer for the age and social structure of the killer and beluga whales to recover. No gray or minke whale mortality is expected to occur as a result of this sale.

Effects to marine mammals due to noise and disturbance also were reviewed and estimated. The loudest noise source created by industry activity was identified as seismic noise. Sounds generated by seismic surveys probably would not affect harbor and fur seal and sea otter activities. Effects on the minke whale have not been studied but likely would be similar to effects on the gray and other baleen whales, which generally are tolerant of seismic pulses. Subtle behavioral changes may occur on occasion at low-sound levels, with stronger avoidance reactions when sound levels reach 160 to 170 dB, or higher. Toothed-whale hearing appears poor at frequencies <1 kHz, where most industrial sounds and seismic pulses are produced, so they probably would be unaffected.

Aircraft overflights can be another potential source of disturbance. Pinniped response to low-altitude aircraft can result in stampede or flight into the water. This may increase pup mortality during the pupping season. Both baleen and toothed whales usually respond to low overflights by diving. Reactions of pinnipeds and cetaceans vary by aircraft type, altitude of flight, and circumstances of the animals. These disturbance reactions usually are short term, with seals reoccupying haulouts and whales continuing their activities usually within a matter of hours.

The effects of habitat alteration/degradation also were examined. These would be limited to temporary disturbance to some sea otters and harbor seals in the nearshore environment associated with construction of pipeline and transport facilities. This disturbance likely would be relatively short term and very localized and should not affect survival.

<u>Conclusion</u>: The OSRA estimates there is a 27-percent chance that one or more spills ≥1,000 bbl could occur. Assuming occurrence and contact (combined probability of >5 percent occurrence and contact to specific land segments or environmental resource areas), the overall estimated effects from an assumed 50,000-bbl-oil spill include potential mortalities of <10 fur seals and killer whales, respectively, with recovery to prespill numbers estimated at 1 to 2 years. Potential mortalities of 43 beluga whales are estimated, using mortalities of killer whales from the EVOS as a basis, with recovery to prespill numbers estimated at 7 years. It may take longer for the age and social structure of the killer and beluga whales to recover. Harbor seal mortality is estimated at 63 seals, and though recovery could not be estimated due to the Cook Inlet seal numbers declining about 50 percent in the last 13 years for unknown reasons, is not expected to have a population-level effect. Gray and minke whales, Dall's porpoises, Pacific white-sided dolphins, and harbor porpoises are expected to experience no long-term effects from a spill or, alternatively, the effects would be unmeasurable. Estimated sea otter mortality would be about 75 to 100 of the approximately 1,000 sea otters resident to Kamishak Bay. Recovery was estimated at about 1 to 2 years.

Seismic noise is expected to have minimal effects (local avoidance) on nonendangered marine mammals. Overflight-disturbances would be reduced by in-place mitigating measures, and displacement effects probably would be short term, with seals reoccupying haulouts and whales continuing their activities usually within a matter of hours. Noise, disturbance and habitat alteration/construction activities would be relatively short term and very localized and should not affect marine mammal survival.

f. **Effects on Endangered and Threatened Species**: Leasing and exploration under the proposed base case may result in acoustic, visual, and altered habitat effects on behavior, distribution, and abundance of individuals or populations occurring in or adjacent to the lease area. However, because areas of known or anticipated use by endangered or threatened species are located primarily in or adjacent to the extreme southern or southeastern portion of the sale area, or farther east or south, only a very small proportion of any species' population is expected to be exposed to routine activities (most of which are confined to local areas) associated with Cook Inlet oil exploration and development, or any oil spill. Drilling muds and cuttings discharged during exploration or development/production activities are not expected to cause significant effects either through direct contact or indirectly by affecting prey populations. Any effects would be limited to individuals in the immediate vicinity due to rapid dilution of such materials or removal from the water column, and/or they are not known to be harmful to the species considered. Crude oil is assumed not to be released during exploration. Development- and production-phase activities are similar to those occurring during exploration plus the additional activity associated with oil transport. A crude-oil spill during development or production would cause effects as discussed below under individual species. In addition, cleanup activities associated with any oil spill may result in disturbance.

During development/production, the estimated probability (expressed as percent chance) of one or more spills ≥1,000 bbl from all sources is 27 percent; estimated mean number of spills is 0.31. For this analysis, one spill (50,000 bbl) is assumed to occur in the sale area (Table IV.B.2-2). The relatively low resource-level estimate for Sale 149 (200 MMbbl) suggests that a significant increase in oil tankered south is not likely to result from this sale.

The OSRA combined probabilities cited in discussions below (Appendix B, Table B-14) were developed from base-case assumptions (resource = 200 MMbbl) and thus represent the estimated probability, expressed as percent chance, of one or more spills ≥1,000 bbl occurring and contacting a specific environmental resource area, land segment, or sea segment (Figs. IV.A.2-2 to 4) within 30 days. The threshold combined probability at which it is assumed that contact and/or damaging effects to the resource would begin to occur, requiring more than a brief interval for recovery of the population to its original status, is 5 percent in the following analyses. The conditional probabilities cited below assume that a spill has occurred, and thus indicate the estimated probability, expressed as percent chance, that the spilled oil will contact a specific environmental resource area or land segment within 30 days during the summer (Appendix B, Tables B-4, B-10) or winter season (Appendix B, Tables B-7, B-13). Also, it is assumed that oceanographic conditions would move any oil spilled in lower Cook Inlet into Shelikof Strait.

The following analysis of potential effects has been extracted from pertinent sections of the *Biological Evaluation for Threatened and Endangered Species with Respect to the Proposed Cook Inlet/Shelikof Strait Oil and Gas Lease Sale 149* included as Appendix I of this EIS, which is incorporated by reference and supplemented by other literature sources as cited.

Pursuant to requirements under the Endangered Species Act of 1973 (ESA), as amended, the MMS, Alaska OCS Region, has consulted with the Fish and Wildlife Service (FWS) and NMFS on previous proposed lease sales in this region (Lower Cook Inlet-Shelikof Strait Sale 60, Gulf of Alaska/Cook Inlet Sale 88). In the Sale 88 biological opinion, FWS concluded that leasing and exploration activities would not be likely to jeopardize the continued existence of short-tailed albatross, arctic and American peregrine falcons, or Aleutian Canada goose. The NMFS concluded that additional OCS activities affecting the North Pacific right whale would be likely to jeopardize its continued existence. In the Sale 60 biological opinion, NMFS concluded that no endangered whale species would be jeopardized by that action.

In accordance with the ESA Section 7 regulations governing interagency cooperation, MMS notified FWS and NMFS on April 6, 1992, of the endangered, threatened, and proposed species that would be included in a biological evaluation for Section 7 consultation. The NMFS responded confirming the species to be included in the evaluation; FWS recommended inclusion of additional species that could be at risk along transportation routes south of the proposed sale area. The biological evaluation was completed and, in accordance with Section 7(a) of the ESA, formal consultations on the proposed Cook Inlet Sale 149 were initiated with FWS and NMFS on March 25 and 26, 1993, respectively. The biological opinion for Sale 149 has been received from NMFS; the FWS biological opinion is under revision based on additional information and consultation. The NMFS has concluded that no listed species would be jeopardized by leasing or exploration activities associated with proposed Sale 149.

(1) **Effects on the Fin Whale**: Fin whales are expected to occur in the proposed sale area or adjacent waters in relatively low numbers (< 1% of its Pacific population). Considered a species of more offshore distribution, fin whales are most likely to occur east and southwest of Kodiak Island during spring (April-June) or fall (September-November) migration; some individuals spend the summer over the Gulf of Alaska shelf, and groups of one to four have been observed consistently in the Kodiak Island inshore area in winter (Zwiefelhofer, 1993, personal comm.).

Exploration activities potentially disturbing to fin whales include drilling operations, aircraft and vessel traffic, and seismic surveys. Pipeline laying, continuous platform activity, and tanker operation are additional potentially adverse activities associated with development and production, together with the potential for an oil spill and subsequent spill-cleanup operations. Discharge of drilling mods and cuttings occurs during both exploration and development.

Fin whales are expected to respond to potentially disturbing activities essentially as reported for the gray whale in the literature. Gray whales have been observed to migrate past drilling units along the California coast without displaying atypical behavior. Avoidance reactions to playback of drilling-unit-underwater sounds have been observed when whales were within 20 m of the sound source (Malme et al., 1989). Malme et al. (1985) derived minimum-avoidance criteria of 500 m for a drilling platform and 1 km for a drillship; conservatively, most individuals are expected to exhibit avoidance behavior within 1 to 4 km of such noise sources. The Sale 149 scenario assumes that a single drilling unit will be in operation during each of two exploration years, and three production platforms in operation for 19 years. If located in an area traversed by fin whales during spring (April-June) or fall/winter (November-December) migration, drilling operations could cause a few whales to divert their direction of travel for an hour or less, resulting in displacements of several hundred meters to a few kilometers from the site (Malme et al., 1984). Such displacement is expected to have a minimal effect, because it is likely to involve much less than 1 percent of the Pacific population temporarily avoiding an extremely small portion of a secondary-use area (lower Cook Inlet/Shelikof Strait) during exploration and development/production.

Likewise, aircraft and vessels servicing exploration or development/production units are expected to influence the behavior of only small numbers of fin whales in a restricted portion of this area. Gray whales overflown by aircraft at altitudes below 450 m (approx. 1,500 ft) may dive in response to the noise and visual stimulus. However, if the aircraft remains on a direct course the whales are expected to continue their normal activities following its departure. Vessels that approach no closer than several kilometers are not expected to disturb fin whales: avoidance of vessels by gray whales occurred when separation was 550 m, or less (Bogoslovskaya, Votrogov, and Semenova, 1981). Vessels that maintain a constant speed and course probably will cause little disturbance of fin whales. In the most likely scenario, a small number of whales traveling in the vicinity of a drilling unit supply route could be exposed to a vessel or aircraft causing them to dive or divert their direction of travel briefly. However, because only one vessel and two helicopter supply trips per day are anticipated (Table IV. A.1-1), travel routes followed by the few whales likely to traverse this area are expected to intersect those of vessels or aircraft infrequently, and thus interactions are expected to be few, responses brief (a few minutes to tens of minutes), and effects minimal. Fin whales may exhibit minor avoidance response if their travel path takes them within 300 m of a tanker; but only a small proportion of the population is expected to be affected, with detectable effects lasting less than an hour.

Fin whales may be present in the vicinity of the proposed lease area in spring and fall when some seismic-survey activity may occur. However, like gray whales, they may be tolerant of distant seismic noise. For example, in experiments conducted along the California coast during the gray whale migration, whales consistently showed no significant avoidance response to an airgun-array vessel at distances of about ≥3 km (Malme et al., 1984; 1989). Conservative criteria developed by Malme et al. (1985) suggest whales will exhibit avoidance of seismic activity at 1 to 2 km. In addition, recovery of bowhead whales to typical surface-respiration-dive characteristics 30 to 60 minutes after disturbance by nearby seismic operations suggests that, to the extent bowhead and fin whale response to disturbance is similar, the effect of such a stimulus typically is brief. The likelihood of the relatively few whales traveling through this area intersecting with seismic vessels operating for short periods in limited areas is expected to be low. Consequently, few whales are expected to interact with seismic vessels and any avoidance responses should be brief, lasting an hour or less, and result in minimal effects.

Potential disturbance resulting from whale-human interaction would be mitigated by adherence to provisions of the Orientation Program and Protection of Biological Resources stipulations, and the Bird and Marine Mammal

Protection and Sensitive Areas ITL's (Sec. II.H). These measures alert personnel to precautions that should be followed where whales occur. In the absence of these measures, the frequency of potentially disturbing interactions between whales and vessels or aircraft would be expected to increase; however, the increase would not be expected to significantly elevate the overall effect of this action on endangered whales.

The addition of pipeline laying and continuous platform operation during development and production is not expected to result in substantially greater disturbance effects than that determined to be minimal during exploration.

The interference by muds and cuttings discharged at a drill site with any foraging whale's ability to locate prey is expected to involve such a restricted area that there would be no adverse effect.

If fin whale-use areas (lower Cook Inlet/Shelikof Strait) are contaminated by an oil spill when whales are present, potential outcomes include avoidance of oiled areas, skin contact with oil, baleen fouling, membrane irritation or ulceration, and respiratory distress caused by inhalation of hydrocarbon vapors. Localized reduction of food resources, consumption of some contaminated prey items or benthic substrate, and/or avoidance of contaminated feeding areas would be significant only if the whales were feeding. Because these areas are used by much less than 1 percent of the Pacific population, only small numbers of individuals potentially could be contacted by a spill.

In the presence of an oil spill, whales may contact oil as they surface to breathe and react by changing their swimming direction to avoid surface oil, as have whales observed off the California coast. Or they may maintain their swimming direction, but breathe less frequently and remain submerged for longer periods, and/or swim faster while in oiled waters. Prolonged contact with respiratory or buccal or eyes or skin may result in irritation or ulceration; however, brief contact is not expected to result in serious long-term harm to whales (Geraci and St. Aubin, 1990). Whales that feed in oiled areas may experience short-term fouling of their baleen; however, oil is not expected to seriously obstruct water flow through the baleen, and filtering efficiencies are expected to return to normal within minutes after feeding in oil (Geraci and St. Aubin, 1990). Hydrocarbon vapor inhaled by whales may result in respiratory distress. However, because most toxic vapors will have dissipated within 24 hours of oil exposure to air, it is unlikely that more than a few of the small number of gray whales in the proposed lease area would be exposed, and no lasting effects are expected. Displacement from local feeding areas, localized reduction of food resources, or consumption of contaminated prey items is expected to affect only small numbers of whales in the proposed sale area.

The estimated combined probability (expressed as percent chance) of a spill occurring and contacting nearshore areas of Shelikof Strait and the southern portion of the proposed sale area (ERA's 6-14) within 30 days in summer, where the small numbers of fin whales that enter this area are most likely to occur, ranges from <0.5 to 4 percent (≤5% is considered a low probability in this discussion). The highest probabilities are concentrated in the Cape Douglas/Hallo Bay and Barren Islands areas (ERA's 6-9), where whales are expected to occur during spring and fall/winter at low density. If a tanker spill occurred outside the entrance to the lower Cook Inlet/Shelikof Strait area along tanker segments T5 to T8 (occurrence probability of one or more spills ≥1,000 bbl is 6%), it could contact portions of the important foraging areas overlying banks east of Kodiak Island (ERA's 18-25) with a conditional probability (expressed as percent chance) ranging from <0.5 to 98 percent (probabilities for most of the migration area are ≤24%; Appendix B, Table B-4). Even in this situation, a relatively small proportion of the population would be expected to encounter oil due to the extended period of fin whale movement to the area, their low density, and likely rapid dispersal of oil in Gulf of Alaska waters. As in the proposed sale area, no mortality would be expected to result from this scenario. In view of the low numbers of individuals potentially affected and relatively minor effects on individuals, overall effect of development and production on fin whales is expected to be minimal.

Contaminants associated with drilling muds essentially are unavailable for bioaccumulation by the organisms eaten by fin whales, should any whales feed in the limited area likely to be contaminated (Neff, 1987; NRC, 1985).

Likewise, oil-spill-cleanup activities, principally the operation of vessels, are not expected to result in significantly greater overall disturbance effects although, if they occur while whales are present, the probability of whale-vessel interaction could be elevated.

Summary: Because potential sources of fin whale disturbance are likely to be localized in a small portion of the proposed sale area and used secondarily by small numbers of whales primarily during migration and summer periods, but also to some extent in winter, <1 percent of its Pacific population is expected to be exposed to disturbance and temporarily avoid these local areas and/or exhibit negative behavioral responses; individual whales are expected to be affected for an hour or less per exposure incident. Likewise, only a few fin whales potentially would be exposed to an oil spill in the proposed lease area or vicinity for a relatively brief interval, resulting in temporary sublethal effects; there is a potential for greater numbers to be exposed over banks east of Kodiak Island, but no mortality is expected to occur. No fin whales are expected to encounter drilling discharges at detectable concentrations due to their rapid dispersal.

Conclusion: The overall effect of exposure of small proportions of the Pacific fin whale population to disturbance and contaminants is expected to be minimal and any incident of extremely short duration; no mortality is expected to result from this lease sale.

(2) **Effects on the Humpback Whale**: The humpback whale, like the fin whale, is expected to occur in the proposed sale area or adjacent waters in relatively low numbers (5% of its Pacific population). Substantial numbers of humpback whales (groups of up to 24 individuals observed) forage over the shelf between the Kenai Peninsula and the eastern Aleutians from July to September. In the Barren Islands, as many as 50 individuals have been sighted simultaneously, with at least 100 present in local areas (Roseneau, 1994, personal comm.). Humpbacks are estimated to be present in this area from late May until mid-November.

Humpback whales are expected to respond to potentially disturbing activities essentially as described for the fin whale; that is, minor behavioral responses or diversion of travel direction in the vicinity of a drilling unit, platform, vessel, or aircraft, lasting an hour, or less.

Effects of an oil spill on humpback whales are expected essentially to be as described for the fin whale. Because <5 percent of the humpback Pacific population is expected to occur in the proposed lease area during migration or the summer season, overall effects of development and production on its Pacific population are expected to be minimal. No effects on the humpback whale population from the EVOS were documented (Dahlheim and Loughlin, 1990). Given the small quantities and/or rapid dilution of drilling-mud contaminants, exposure of humpback whales to detectable concentrations is not expected to occur.

Summary: Because potential sources of humpback whale disturbance are likely to be localized in a small portion of the proposed sale area, used only secondarily by small numbers of whales primarily during migration and/or summer periods, <5 percent of its Pacific population is expected to be exposed to disturbance and exhibit adverse effects; individual whales are expected to be affected for an hour or less per exposure incident. Likewise, only a few humpback whales potentially would be exposed to an oil spill in the proposed lease area or vicinity for a relatively brief interval, resulting in temporary sublethal effects. No humpback whales are expected to encounter drilling-mud contaminants.

Conclusion: The overall effect of exposure of small proportions of the humpback whale population to disturbance and contaminants is expected to be minimal and any incident of extremely short duration; no mortality is expected to result from this lease sale.

(3) **Effects on the Sei, Blue, Right, and Sperm Whales**: These whales are expected to occur in the proposed sale area or adjacent waters in even lower numbers than the two species discussed above (i.e., much less than 1% of their Pacific populations). These species generally are considered of more offshore distribution, more likely to occur east and southwest of Kodiak Island foraging over the outer continental shelf and slope or deeper waters from May through September.

These species are expected to respond to potentially disturbing activities essentially as described for the fin whale; that is, minor behavioral responses or diversion of travel direction in the vicinity of a drilling unit, platform, vessel, or aircraft, lasting an hour or less. Effects of an oil spill on these whales are expected to be essentially as described for the gray whale. Likewise, no whales are expected to be exposed to drilling-mud contaminants.

Summary: Because potential sources of sei, blue, right, and sperm whale disturbance are likely to be localized in a small portion of the proposed sale area and the sale area entered infrequently by small numbers of these whales during migration or summer periods, much less than 1 percent of their Pacific populations are expected to be exposed to disturbance and exhibit temporary adverse reactions; individual whales are expected to be affected for an hour or less per exposure incident. Likewise, potentially few whales would be expected to encounter an oil spill in the proposed lease area or vicinity for a relatively brief interval, resulting in temporary sublethal effects. Given the small quantities and/or rapid dilution of drilling-mud contaminants, exposure of these whales to detectable concentrations is not expected to occur.

Conclusion: The overall effect of exposure of extremely small proportions of sei, blue, right, or sperm whale populations to disturbance and contaminants is expected to be minimal and any incidents of extremely short duration; no mortality if expected to result from this lease sale.

(4) Effects on the Steller Sea Lion: Exploration activities potentially disturbing to Steller sea lions include aircraft and vessel traffic, seismic surveys, and drilling operations. Pipeline laying, continuous platform operation, and tanker operation are additional activities associated with development and production, together with the potential for an oil spill and subsequent spill-cleanup operations. Although the possible effects of various types of disturbance on sea lions have not been studied specifically, any disturbance may cause increased energy expenditure; and operation of aircraft over or vessels near rookeries is observed to cause adult stampedes that may result in trampling or abandonment of pups. However, only under exceptional circumstances would close approach of rookeries in the vicinity of the Sale 149 area (located on Marmot and Sugarloaf Islands) by vessels or personnel be expected to occur. Because all haulouts are located well outside the Sale 149 area to the east or south, routine approach by aircraft or vessels that might result in avoidance of such areas by sea lions also is not expected to occur.

Sea lions may avoid potential foraging and traditional rafting areas near the drilling unit and supply routes; however, such displacement is expected to have a minimal effect because it is likely to involve <2 percent of the Gulf of Alaska population temporarily avoiding a small proportion of their available range. Likewise, operation of three production platforms for 19 years is expected to have a minimal effect on sea lions.

Travel routes of the few sea lions likely to traverse the area between shore facilities and a drilling unit are expected to infrequently intersect those of supply or seismic vessels or aircraft, and thus interactions are expected to be few, avoidance responses brief (a few minutes to tens of minutes), and effects minimal. No onshore construction projects are likely to be located near sea lion rookeries or major haulout areas. Potential disturbance resulting from sea lion-human interaction would be mitigated by adherence to provisions of the Orientation Program and Protection of Biological Resources stipulations, and the Bird and Marine Mammal Protection, Sensitive Areas, and Steller Sea Lion ITL's (Sec. II.H). These measures alert personnel to precautions that should be followed where sea lions occur. In the absence of these measures, the frequency of potentially disturbing interactions between sea lions and vessels or aircraft would be expected to increase; however, the increase would not be expected to significantly elevate the overall effect of this action on sea lions.

Oil spills are expected to result in adverse effects if they contact Steller sea lions, haulouts or rookeries when occupied, or large proportions of major prey populations. Potential effects of oil exposure, including surface contact and pelage fouling, inhalation of contaminant vapor, and ingestion of oil or oil-contaminated prey, are discussed in USDOI, MMS, Herndon (1992) and by Geraci and St. Aubin (1988, 1990). Because the insulation of nonpup sea lions is provided by a thick fat layer rather than pelage whose insulative value could be destroyed by fouling, oil contact is not expected to cause death from hypothermia; however, sensitive tissues (e.g., eyes, nasal passages, mouth, lungs) are likely to be irritated or ulcerated by exposure to oil or hydrocarbon fumes. Oiled individuals probably will experience effects that may interfere with routine activities for a few hours to a few days; movement to clean water areas is expected to relieve most symptoms. Females returning from feeding trips may transfer oil to pups, which probably are more sensitive to oil contact. The extent to which sea lions avoid areas that have been oiled is not known; individuals observed in Prince William Sound after the EVOS did not appear to avoid oiled areas (Calkins and Becker, 1990).

Based on modeled oil-spill trajectories for Cook Inlet/Shelikof Strait and information concerning the EVOS movement, an oil spill in the proposed lease area could contact one or more sites of sea lion concentration. However, the estimated combined probability of one or more ≥1,000-bbl spills occurring and contacting areas from the southern sale area south through Shelikof Strait (expected route of any spill in the sale area) where sea lion haulouts or rookeries are located (ERA's 6-14) within 30 days in summer is low, ranging from <0.5 to 4 percent

(Appendix B, Table B-14; Fig. IV.B.1.d-1). The highest combined probabilities are concentrated in the Cape Douglas/Kukak Bay and Barren Islands areas (ERA's 6-10), which includes the Sugarloaf Island rookery.

If a spill were to occur in the season of peak attendance along tanker (T1 and T2) or pipeline (P1 and P2) segments in the northern half of the sale area, the conditional probability of contacting individuals at 7 of 12 Shelikof Strait or Barren/Shuyak Islands haulout areas (ERA's 6-13), which include approximately 8 percent of the central Gulf of Alaska population (approximately 800-1,000), is <5 percent (<0.5% at the remainder) (Appendix B, Table B-4). A spill originating in the southern half of the sale area (pipeline segments P3 through P5, tanker segment T3) or nearby tanker segments (T4-T5) could contact individuals from 11 of the 12 haulouts comprising 10 percent of this population with probabilities ranging from 1 to 95 percent (most values ≤30%). Historically, substantial numbers of sea lions have hauled out in Puale Bay; however, this area (ERA 12) is at a relatively low chance of contact from any spill that occurs in the sale area or along tanker segments (conditional probability = <0.5-7%); the chance of spill occurrence and contact in this area is <0.5 percent (Appendix B, Tables B-4 and B-14). As a result, the overall risk of substantial numbers of sea lions being contacted over the life of the field is considered minimal.

Although the probability of one or more spills actually occurring is relatively low (6%), if one did occur outside the inlet (tanker segments T4-T8) it could contact Marmot Island (largest regional rookery, ERA's 8 and 24) or haulouts (comprising 11% of the central gulf population) on the eastern shore of Kodiak Islands (ERA's 18 through 19 and 21 through 22) with conditional probabilities ranging up to 23 percent and 4 percent, respectively (Appendix B, Table B-4, Fig. IV.B.1.g-1).

A spill that moves into the vicinity of larger rookeries or haulouts adjacent to the sale area during the breeding season is expected to contact up to several hundred individuals. Although adult mortality is not expected to exceed a few tens of individuals, such an incident may result in adverse effects on production of young (currently a growing problem; Merrick, 1993, personal comm.), and survivorship of oiled juveniles (Calkins and Pitcher, 1982), potentially additive to factors causing the current population decline and requiring at least one generation for recovery. In pelagic areas, near minor rookeries or haulouts, or during the nonbreeding season, individuals may not be as concentrated so numbers contacted by a spill are not expected to exceed 100 individuals; however, failure of the population to recover from the current decline suggests that even small losses may require a substantial period for recovery.

Small, localized spills <1,000 bbl of crude oil (average = 5 and 160 bbl) or other contaminants are assumed not likely to contact areas of sea lion concentration, including those adjacent to the sale area and in the lower 48 states, before weathering, dispersal by strong winds and currents, or cleanup, renders them relatively harmless. As a result, only a few individuals would be likely to be exposed to detectable concentrations or experience the transitory effects that occur in the event of a larger spill.

Containment and cleanup operations associated with an oil spill near a sea lion rookery may result in some disruption of female-pup bonds, pup mortality from trampling by disturbed adults, and temporary abandonment of the affected areas. Although this is likely to be a local effect, the occurrence of much of the regional populations' pup production at just a few rookeries suggests that such activity near a major rookery could result in losses requiring a substantial period for recovery under current population dynamics, unless mitigated through avoidance of these areas by cleanup crews during the breeding season, as advised by the mitigating measures noted above. Effects of potentially disturbing activities associated with development and production, generally occurring far removed from sea lion concentrations, are expected to be minimal.

<u>Summary</u>: Because potential sources of Steller sea lion disturbance are likely to be localized in a small portion of the proposed sale area, <2 percent of the Gulf of Alaska population is expected to be exposed to disturbance; individual sea lions are expected to be affected for a few minutes to tens of minutes per exposure incident. Also, because sources of disturbance are likely to be distant from rookeries, pup mortality from adult trampling is not expected to occur, although spill-cleanup activity could result in loss of some pups. The combined probability (expressed as percent chance) of one or more ≥1,000 bbl oil spills occurring and contacting areas where sea lion haulouts or rookeries are located within 30 days is low, ranging from <0.5 to 5 percent. Although a spill that moves into an area of concentrated use, especially during the breeding season, is expected to contact up to several hundred individuals, adult mortality is not expected to exceed a few tens of individuals; however, such an incident may result in adverse effects on production of young (currently a growing problem) and survivorship of oiled pups

or juveniles, potentially additive to factors causing the current population decline. Thus, although exposure of the Steller sea lion population occupying a portion of the proposed sale area and vicinity to an oil spill is expected to result in loss of <100 individuals, <0.3 percent of the Gulf of Alaska population, recovery from any such loss is expected to require at least one generation.

Conclusion: Overall effect of Steller sea lion exposure to disturbance and minor contaminants is expected to be minimal; mortality resulting from an oil spill is expected to require at least one generation for recovery.

(5) **Effects on the Short-Tailed Albatross:** Although short-tailed albatrosses formerly (pre-1900) were sighted frequently in inshore and shallow offshore waters of Alaska, including the proposed Sale 149 area, sightings have been rare since this time and predominantly in the western Aleutians since 1950 (Hasegawa and De Gange, 1982). Sighting frequency of the previous 30-year interval suggests that fewer than five individuals would be expected to occur in the vicinity of the Sale 149 area over the life of the field, with the probable number being one.

Aircraft probably is the only potential source of disturbance of this species; however, in view of the small proportion of the sale area likely to be traversed by support aircraft, exposure of a single albatross to such disturbance is expected to be an extremely rare event, lasting a few minutes to tens of minutes, and resulting in minimal effect. Albatrosses routinely ingest floating material such as small plastic or other items. Although such material is known to accumulate in the gut, its effect on adult physiology has not been determined with certainty. However, it is apparently a negative factor in chick fledging weight (Sievert, 1990); but chicks in the Japanese nesting area are not expected to be fed items originating in the Sale 149 area. If such material (e.g., styrofoam packing, wood chips) were blown off a rig or supply vessel, an albatross could encounter it; but the expected rarity of albatross occurrence and debris of oil-and-gas industry origin in this area suggests that such encounters will not take place. Existing regulations prohibit the discharge of plastics from rigs (MARPOL, 1973).

Exposure of albatrosses to oil potentially could result in effects ranging from tissue irritation to plumage fouling and death from hypothermia; intake of oil through consumption of contaminated prey, by preening, or inhalation of hydrocarbon fumes could interfere with various physiological functions and/or cause organ damage. However, as a result of short-tailed albatross rarity in the vicinity of both the proposed sale area and transportation corridors, the relatively low combined probability (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting any area where an albatross might occur (≤8%), and existence of strong winds and currents that would promote rapid dilution of any spill in the sale area in particular, short-tailed albatrosses are not expected to be exposed to an oil spill of detectable concentration. Nor are albatrosses expected to be influenced by oil-spill-cleanup activities.

Conclusion: The overall effect of exposure of the short-tailed albatross to disturbance, debris, and contaminants is expected to be minimal or none.

(6) **Effects on the Aleutian Canada Goose:** The small Aleutian Canada goose population (25+pairs) breeding or summering on Kiliktagik and Anowik Islands in the Semidi Islands (Hatch and Hatch, 1983) is not expected to experience adverse effects from potentially disturbing activities because of its distance from the proposed Sale 149 area (approximately 110 mi). Occurrence of individuals in the vicinity of the Sale 149 area east of the town of Kodiak has been documented recently (MacIntosh, 1993, personal comm.).

Exposure of Aleutian Canada geese to oil would be expected to have the general effects noted for the previous species. Geese could be vulnerable to oil spills during the breeding season if they spent time in the intertidal zone or in or flying low over waters surrounding the nesting island in the Semidi Islands southwest of the proposed sale area. However, the lack of a substantial intertidal zone suitable for use by geese in this area, the observation that breeding Aleutian Canada geese seldom rest on or fly low over saltwater, and the considerable distance a weathering and dispersing oil spill must traverse from the sale area to the Semidi Islands, supports the view that these geese would not be exposed to an oil spill during the breeding season. In addition, the combined probability (expressed as percent chance) of one or more ≥1,000-bbl oil spills occurring and contacting the Semidi Islands (ERA 16) within 30 days, as well as the conditional probability of oil spilled from tanker and pipeline segments T1 through T8 and P1 though P5 in the sale area reaching these islands, is <0.5 percent (Appendix B, Tables B-14, B-4; Fig. IV-B.1.d-1).

Potential disturbance by cleanup activities associated with any oil spill that reaches the Semidi Islands is expected to be remote from nesting geese and/or be effectively mitigated. Likewise, the combined probability (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting bays east of the town of Kodiak (ERA 22) where some geese may stop during migration is <0.5 percent.

Summary: Because potentially disturbing activities associated with this sale would be far removed from the Semidi Islands, Aleutian Canada geese are not expected to experience any effect from such activities. Likewise, because the combined probability (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting the Semidi Islands and Kodiak Island bays is low and geese do not typically occupy habitats likely to be oiled, the effect of any oil spill is expected to be minimal.

Conclusion: Overall effects on the Aleutian Canada goose are expected to be minimal, affecting <1 percent of the population.

(7) **Effects on the Steller's Eider:** Steller's eiders wintering in nearshore areas along the Alaska Peninsula to Kodiak Island and southern Cook Inlet are not expected to experience adverse effects from potentially disturbing routine activities because of the distance separating most of the wintering population from the proposed Sale 149 area. Although several thousand occupy the Shelikof Strait during this season, relatively few individuals occur north of Kodiak Island.

Exposure of Steller's eiders to oil would result in the general effects noted for the previous species (not expected to survive contact). A substantial proportion of the eider population could be vulnerable to any oil spill contacting the lower Cook Inlet/Shelikof Strait coastline during the winter season; however, the population is spread in relatively small flocks along this lengthy coast, so <2 percent of the population is expected to be contacted by an oil spill. The combined probability (expressed as percent chance)of one or more ≥1,000-bbl spills occurring and contacting occupied areas (ERA's 7-14) is low, ranging from <0.5 to 4 percent. If a spill occurred, the conditional probability of contact from T1 through T8 and P1 through P5 in these areas generally is ≤17 percent (most, <0.5-10%), although in the north (ERA's 7-9) it ranges from 30 to 65 percent (Appendix B, Tables B-4, B-14). Thus, although relatively low Steller's eider mortality is expected from an oil spill, recovery from spill-related losses may require as much as two generations in view of their declining numbers on the breeding grounds in recent decades and their relatively low reproductive rate.

Summary: Because potentially disturbing routine activities associated with this sale would be far removed from most of the Steller's eiders wintering along the Alaska Peninsula and Kodiak Island, the population is not expected to experience any significant effects from such activities. Although relatively low Steller's eider mortality is expected from an oil spill, recovery from spill-related losses may require as much as two generations in view of their declining numbers on the breeding grounds in recent decades and their relatively low reproductive rate.

Conclusion: Overall routine effects on the Steller's eider are expected to be minimal, affecting <2 percent of the population; however, mortality resulting from an oil spill is expected to require up to two generations for recovery.

(8) **Effects on the Peregrine Falcon:** Migrating peregrine falcons following the Pacific flyway from western interior nesting areas, or occasional overwintering individuals, potentially could occur seasonally in coastal areas adjacent to the proposed Sale 149 area, although such occurrence is expected to be irregular and infrequent (<3% of the Alaskan population). Such individuals could be disturbed on rare occasions by aircraft flights from an air-support site (e.g., Kenai) to a drill rig in the sale area; avoidance responses exhibited by peregrines exposed to nearby aircraft are expected to last for a few minutes to tens of minutes per incident. Because the frequency of such support flights is likely to be only one to two per day, confined to relatively restricted corridors, intersection of their flight paths with those of uncommon migrant or overwintering peregrine falcons is expected to be infrequent and effects on the population minimal.

Peregrine falcons present in the vicinity of the sale area during migration or winter may become oiled through contact with oiled prey or substrate in the vicinity of a spill, may ingest oil, or may be affected indirectly through a reduction in prey such as seabirds or waterfowl. However, the probability of contact would be reduced by their transient occurrence in the area and their habit of not typically making extensive contact with water when taking prey in this environment. Exposure of peregrines to oil would be expected to have the general effects noted for the previous species. Although reduction in prey abundance by an oil spill could result in short-term, localized reductions in food availability, it is unlikely to have a significant effect on migrant falcons. The effects of oil-spill-cleanup activities on peregrine falcons are expected to be minimal.

Summary: Because potential sources of peregrine falcon disturbance are likely to be localized in a small portion of the proposed Sale 149 area, and this species is of uncommon occurrence in the vicinity, <3 percent of the population potentially could be exposed to disturbance and exhibit avoidance effects for a few minutes to tens of minutes per exposure incident. As a result of their transient occurrence in the area and foraging habits, and the low probability of oil-spill occurrence and contact where peregrines might occur, they are not expected to experience oil-spill effects.

Conclusion: The overall effect on the peregrine falcon is expected to be minimal, with <3 percent of the population exposed to potentially adverse factors.

(9) **Effects on the Southern Sea Otter**: Southern sea otters inhabit shallow, coastal waters, generally within 2 km of shoreline, in central California; a few individuals from a translocated group survive on San Nicolas Island. The coastal population is estimated to have increased at a rate of 5 to 7 percent per year since the mid-1980's to about 2,000 individuals as of 1991.

Southern sea otters may be affected adversely by an oil spill from a tanker transporting oil to California ports from the proposed Cook Inlet sale area. Potential effects include oil contamination of their insulative fur resulting in hypothermia, inflammation/lesion of sensitive tissues following oil contact, tissue or organ damage from ingested oil, and emphysema from inhaled vapors (Geraci and St. Aubin, 1988, 1990; Geraci and Williams, 1990). Stress in captive oiled individuals handled for cleaning may contribute to effects from oiling. Potential indirect effects from an oil spill include a reduction in available food resources due to mortality or unpalatability of prey organisms, and loss of habitat available to otters if kelp forest communities become contaminated (Riedman, 1987).

Oil from the proposed sale area likely would be transported to lower 48 ports in relatively small tankers a averaging 45,000 DWT (approximately 325,000-bbl capacity). Tankers traveling from Alaska to Pacific coast ports generally follow routes at least 160 km offshore to turning points from which they travel via Traffic Separation Schemes directly to precautionary areas at port entrances. For example, a tanker may travel to a turning point approximately 210 km west of Cape Buchon near the southern portion of the sea otter range; from there the designated route approaches Los Angeles directly, within 15 km of the coast when rounding Point Conception. In recent years, some shippers have used an alternate approach from the south, circumnavigating the Channel Islands by about 150 km. Currently, the U.S. Coast Guard is evaluating vessel routing and port access schemes for California (58 *FR* 44834). An estimated 45 tankers/year would be required to transport Sale 149 oil if all projected resource is recoverable and shipped south rather than refined locally; the latter is a likely scenario for some proportion of the oil. Thus, an estimated 14.5 MMbbl could be shipped to west coast ports annually. Of this, approximately 4 MMbbl is expected to be offloaded at Los Angeles; this represents only 2.4 percent of the amount currently arriving at this port from the Trans-Alaska Pipeline System (USDOI, MMS, 1994). Similar percentages would arrive at Puget Sound and San Francisco.

The amount of coastline contacted by an oil spill from a tanker (estimated probability of occurrence is 6% in the potentially affected area) may vary depending on volume of oil released, wind direction and speed, current direction and velocity, tidal cycle, coastal bathymetry, and distance of the spill from shore (e.g., probability of a spill that occurs 80 km or farther offshore in the southern California area contacting shore in the sea otter range is <1 percent in spring; USDOI, MMS, Herndon, 1992). A model incorporating these variables and historical spill data estimates that a 10,000- or 30,000-bbl spill in the Santa Maria Basin, for example, within approximately 40 km of the coast where the probability of shore contact in spring estimated from Ecological Consulting Inc. (1990) ranges from 1 to 5 percent, may spread along approximately 30 to 60 km of coastline, respectively (Ford and Bunnell, 1987; USDOI, MMS, Herndon, 1992). Within this coastal area, a 1991 survey estimated 254 otters in the 30-km segment and 430 in the 60-km segment, or about 13 and 22 percent of the California population, respectively (USDOI, MMS, Herndon, 1992). Some mortality would be expected if such a spill occurred and contacted the shoreline in this area, although the magnitude of mortality would vary with several factors including time of year, wind patterns, currents, volume of oil entering the nearshore area, condition of the oil upon contact, the success of containment/cleanup operations, number of animals contacted, the severity of contact of individuals, and the effectiveness of otter cleaning and rehabilitation. Recent California legislation provides for the construction of a facility for cleaning and rehabilitating oiled otters and development of a Statewide program to address the needs of oiled wildlife.

As a consequence of the number of variables involved, the possible range of effects to the otter population is large; highly weathered oil from a distant spill is likely to result in little or no mortality, while a spill near shore may oil hundreds of individuals and result in high mortality. Although it is unlikely that all individuals in this 30- to 60-km area would die as a result of a spill, recovery from a loss of 13 to 22 percent of the population (which does represent a loss of all individuals in this area), for example, is estimated to require from 2 to 3 to 4 to 5 years (about 1 generation) at an annual population growth rate of 5 to 7 percent (USDOI, FWS, Southern Sea Otter Recovery Team, 1991; USDOI, MMS, Herndon, 1992). Alternatively, studies following the EVOS provide estimates of sea otter mortality resulting from a large spill; in this case losses were estimated to be 42 percent of the individuals in the spill area. Applying this proportion to the 30,000-bbl southern California example above, and adjusting for spill size (refer to Sec. IV.B.1.e; e.g., adjustment factor for a 30,000-bbl spill = .12), an estimated 23 otters representing 1 percent of the California population (5% of the local population) would be expected to die; recovery from this loss is expected to require no more than 1 year (<1 generation). The foregoing assumes, of course, that there is a relationship between the amount of oil spilled and otter mortality due to oil contact, and that interaction of other variables is comparable. Finally, a tanker spill that contacts the south side of San Nicolas Island probably would eliminate this translocated population.

__Summary:__ Sea otters inhabiting coastal areas of central California are vulnerable to oiling, which destroys the insulative properties of their fur, often resulting in death from hypothermia or other complicating effects. An oil spill also may reduce available food resources. A spill contacting 30 to 60 km of coastline in the southern portion of the otter's range adjacent to the Santa Maria Basin could affect an estimated 254 to 430 individuals, equivalent to 13 to 22 percent of the California population. Mortality would vary depending on number of individuals contacted, severity of contact, and effectiveness of otter cleaning and rehabilitation. Although it is unlikely that all individuals in an area contacted would die, recovery from a loss of 13 to 22 percent of the population (which does represent a loss of all individuals in this area), for example, is estimated to require 2 to 5 years (1 generation) at the current population growth rate. Mortality estimated from EVOS studies would be expected to be 23 otters (representing 1% and 5% of the California and local populations, respectively) and require a shorter interval for recovery, perhaps 1 year at current population growth rate.

__Conclusion:__ Mortality of southern sea otters resulting from any spill of oil (estimated probability of occurrence is 6% in the potentially affected area) tankered from the Sale 149 area to southern California is expected to be moderate (estimated 23 individuals) with an estimated 1-year-recovery time (<1 generation). However, conditions prevailing at the time of a spill could cause much greater mortality to occur requiring up to 5 years (1+generation) for recovery. Similar results would be expected if a spill were to occur in other portions of the otter range.

(10) Effects on the Marbled Murrelet: In the marine environment, marbled murrelets typically inhabit nearshore waters that roughly correspond to the discontinuous distribution of inland nesting habitat in Washington, Oregon, and California. In California, a 480-km gap exists between the southernmost concentration in San Mateo County and that in Humboldt County. Another gap exists south of the Olympic Peninsula in Washington. The number of pairs in Washington is estimated to be about 2,500, with <1,000 each in Oregon and California. Recent surveys indicate that recruitment of juvenile murrelets into the population is low.

Marbled murrelets may be affected adversely by an oil spill from a tanker transporting oil to Washington or California ports from the proposed Cook Inlet sale area. Potential effects include oil contamination of their insulative plumage resulting in death from hypothermia, inflammation/lesion of sensitive tissues following oil contact, tissue or organ damage from ingested oil, and emphysema from inhaled vapors. Murrelets are not expected to survive oiling unless the proportion of plumage oiled is slight. Potential indirect effects from an oil spill include a reduction in available food due to mortality of prey organisms.

Oil from the proposed sale area is likely to be transported to lower 48 ports in relatively small tankers averaging 45,000 DWT (approximately 325,000-bbl capacity). Tankers traveling from Alaska to Pacific coast ports generally follow routes at least 160 km offshore to turning points from which they travel via Traffic Separation Schemes directly to precautionary areas at port entrances. For example, a tanker may travel to a turning point approximately 240 km west of Cape Mendocino at the midpoint of the population gap between San Mateo and Humboldt Counties; from here the designated route approaches San Francisco with closest approaches of 148 km from Cape Mendocino, 60 km from Point Arena, and 46 km from Bodega Head (USDOI, FWS, 1987). Currently, the U.S. Coast Guard is evaluating vessel routing and port access schemes for California (58 *FR* 44834). An estimated 45 tankers/year would be required to transport Sale 149 oil if all projected resource is recoverable and shipped south rather than refined locally; the latter is a likely scenario for some proportion of the oil. Thus, an estimated 14.5 MMbbl could be shipped to west coast ports annually. Of this, approximately 2.4 MMbbl is expected to be offloaded at San Francisco this represents only 2.3 percent of the amount currently arriving at this port from the Trans-Alaska Pipeline System (USDOI, MMS, 1994, personal comm.). A similar percentage would arrive at Puget Sound.

The amount of coastline habitat contacted by an oil spill from a tanker (estimated chance of occurrence is 6% in the potentially affected area) may vary depending on volume of oil released, wind direction and speed, current direction and velocity, tidal cycle, coastal bathymetry, and distance of the spill from shore (e.g., probability of a spill occurring 130 km or farther offshore at the latitude of the southernmost marbled murrelet nesting range is <1% in spring; Ecological Consulting, Inc., 1990). The probability of shore contact in spring northward from the vicinity of San Mateo County, up to 55 to 65 km offshore, exceeds 10 percent. A model incorporating these variables and historical spill data estimates that a 10,000- or 30,000-bbl spill off southern California, for example, within approximately 40 km of the coast may spread along approximately 30 to 60 km of coastline, respectively (Ford and Bunnell, as cited in USDOI, FWS, 1987; USDOI, MMS, Herndon, 1992). Assuming a similar spill distribution would occur within the murrelet range of northern California and incorporating survey results cited by Carter and Erickson (1988), expected contact would range from 72 to 144 individuals, respectively, in the area north of Humboldt Bay and 30 to 60 individuals, respectively, in the area from Santa Cruz to Pillar Point. These values represent approximately 4 to 9 percent and 2 to 4 percent, respectively, of the total estimated California population (Carter and Erickson, 1988). If such a spill occurred and contacted the shoreline in these areas, a large proportion of contacted birds would be expected to die, although the magnitude of mortality would vary with several factors including time of year, wind patterns, currents, volume of oil entering the nearshore area, condition of the oil upon contact, the success of containment/cleanup operations, number of individuals contacted, severity of contact, and the effectiveness of cleaning and rehabilitation efforts. Recent California legislation provides for the development of a Statewide program to address the needs of oiled wildlife.

As a consequence of the number of variables involved, the possible range of effects to the murrelet population is large; highly weathered oil from a distant spill may result in little mortality, while a spill near shore may oil hundreds of individuals and result in high mortality. Although it is unlikely all individuals in these 30- to 60-km areas would die as a result of a spill, recovery from a loss of 2 to 9 percent of the population (which does represent a loss of all individuals estimated to occupy these areas), for example, is estimated to require from 1 to 5 years at an annual population recruitment rate of 2 percent if all fledglings survived (Strong, et al., 1993; 59 *FR* 3811). Incorporating an estimate typical of fledgling survival in such alcid species, recovery from the estimated losses could require from 3 to 15 years.

Summary: Marbled murrelets inhabiting coastal areas of northern California are vulnerable to oiling, which destroys the insulative properties of their plumage, usually resulting in death from hypothermia or other complicating effects. An oil spill also may reduce available food resources. A spill contacting 30 to 60 km of coastline where murrelets are concentrated in nearshore areas corresponding to the remaining inland nesting areas could impact an estimated 30 to 144 individuals, equivalent to 2 to 9 percent of the California population. Mortality would vary depending on number of individuals contacted, severity of contact, and effectiveness of cleaning and rehabilitation. Although it is unlikely that all individuals in an area contacted would die, recovery from a loss of 2 to 9 percent of the population (which does represent a loss of all individuals in the two areas described), for example, is estimated to require at least 1 to 5 years at the current population recruitment rate, and 3 to 15 years if survival rate remains typical of such alcid species.

Conclusion: Mortality of marbled murrelets resulting from any spill of oil (estimated probability of occurrence is 6% in the potentially affected area) tankered from the Sale 149 area to northern California is expected to be high (estimated 30-144 individuals, 2-9% of the California population) with an estimated 3- to 15-year (2-8 generations) recovery time. Similar results would be expected if a spill were to occur in other portions of the murrelet range.

(11) Effects on Other Species Potentially Affected Along Southern Transportation Corridors: Populations of many endangered, threatened, proposed, and candidate species occur in marine or coastal habitats near transportation routes or shipping lanes adjacent to portions of the Pacific coast of Canada and the lower 48 states; if development and production result from proposed Sale 149, tankers may transport some portion of the product along these routes thereby potentially placing these populations at risk from oil spills and spill-cleanup activities.

The potential effects that vulnerable populations of particular species would be expected to exhibit are discussed in the *Biological Evaluation for Threatened and Endangered Species with Respect to the Proposed Cook Inlet/Shelikof Strait Oil and Gas Lease Sale 149*, pertinent sections of which are included in this document as Appendix I and summarized below.

Many species occupy coastal habitats that are not expected to be exposed to the same risk as those offshore. In particular, shoreline habitats (e.g., foredunes) occupied by plant, insect, and mammal species are not expected to be contacted by oil originating from a tanker under typical weather conditions. Nor are substantial numbers of the fish, bird, mammal, and other species occupying coastal saltmarshes, bays with constricted entrances, or lower portions of the freshwater tributaries to such bays expected to experience substantial contamination under typical weather conditions, because equipment to prevent oil from entering these habitats from offshore locations is readily available throughout the region of concern. At most, the loss or displacement of small numbers of individuals is not expected to require more than two generations for recovery—for most species no more than 2 years.

Species occupying more exposed marine habitats may be more vulnerable to oil-spill contact, but circumstances associated with their seasonal distribution and abundance or behavior may mitigate the severity of oil-spill effects. In addition, along much of the coast from southeast Alaska southbound tankers follow routes 100 to 150 mi offshore, providing a coastal buffer in which any spilled oil would be expected to undergo considerable dispersal and weathering before nearshore contact. Also, the conditional probability of spilled oil contact along California shorelines is ≤15 percent (USDOI, MMS, 1984). Further, the potential for exposure of species occupying coastal areas in southern California to a tanker spill is expected to be decreased by oil industry routing of tankers seaward of the Channel Islands in either approach, for example, to the Los Angeles area. Thus, the effect of southern transportation on whales is expected to be minimal; on the Steller sea lion, to require no more than two generations for recovery; and on all other mammal, bird (except marbled murrelet, discussed above), reptile, and other species, to require no more than one generation for recovery—for most species no more than 1 year.

Conclusion: The effect of any tanker spill on most species occurring in the vicinity of southern transportation routes is expected to be minimal, or have no effect, as a result of the low combined probability that oil will be spilled and contact occupied habitats. Effects on most species occupying saltmarsh, bay, and tributary habitats are expected to require no more than two generations for recovery. The effect on most species occurring in exposed marine habitats is expected to require no more than one generation for recovery; the Steller sea lion is expected to require no more than two generations, the southern sea otter slightly more than one generation, and the marbled murrelet two to eight generations.

(12) General Conclusions, Endangered and Threatened Species: The overall effect of exposure of endangered whales to disturbance and contaminants within or outside the proposed sale area is expected to be minimal; no mortality is expected to result from this lease sale. The effects of Steller sea lion exposure to disturbance and minor contaminants within or outside the sale area is expected to be minimal; mortality resulting from an oil spill is expected to require at least one generation for recovery. The effects of this sale on the short-tailed albatross, Aleutian Canada goose, and peregrine falcon within or outside the sale area are expected to be minimal. The effect of a spill on Steller's eiders wintering near the sale area is expected to require up to two generations for recovery. Because the estimated probability of tanker-spill occurrence is only 6 percent, the risk of Sale 149 on species in the vicinity of southern tanker routes is considered to be negligible. Any large spill involving oil from the Sale 149 area is expected to result in effects as discussed above under the individual species' accounts.

g. Effects on Terrestrial Mammals: Of the approximate 38 species of terrestrial mammals that occur in the lower Cook Inlet coastal area, river otters, brown bears, and Sitka black-tailed deer are the species of terrestrial mammals most likely to be affected to some degree by oil and gas exploration and development associated with the proposal. Primary effects are expected to come from potential oil spills and lesser effects from noise and disturbance associated with air and vessel traffic.

(1) **Oil-Spill Effects:** In general, the effects of potential oil spills on terrestrial mammals would result from oil contamination of individual mammals, contamination of coastal habitats, and contamination of some local food sources.

(a) **Effects on Sitka Black-Tailed Deer:** Sitka black-tailed deer depend primarily on sedges, kelp, and tidal vegetation along coastal beaches during severe winters. If an oil spill contacts these coastal areas, this vegetation could be heavily contaminated or destroyed by the spill. If kelp and other tidal vegetation became heavily oiled from a spill occurring during a severe winter along the western coast of Kodiak and Afognak Islands, Sitka black-tailed deer wintering in the area could suffer the loss of winter forage and ingestion of contaminated vegetation. This ingestion could result in mortality if the oil is fresh. Toxicity studies of crude-oil ingestion in cattle (Rowe, Dollahite, and Camp, 1973) indicate that anorexia (with significant weight loss) and aspiration pneumonia leading to death are possible consequences of oil ingestion in deer. Although the fur of deer might become oiled by a spill, they are not expected to suffer any loss of thermal insulation—but some hydrocarbons could be absorbed through the animal's skin. The combination of oil ingestion and hydrocarbon absorption and loss of winter forage could increase winter mortality among Sitka black-tailed deer on Kodiak and Afognak Islands.

The examination of deer tissues from animals collected in Prince William Sound after the EVOS indicated no apparent evidence of oil ingestion, and examination of deer carcasses collected up to about 1 year after the spill did not show any oil-related mortality (Lewis and Calkins, 1991). However, if the spill had occurred during the middle of the winter when deer forage heavily on kelp and other tidal vegetation, ingestion of oiled vegetation by deer might have occurred and the spill could have contributed to some winter mortality in the deer population.

(b) **Effects on Brown Bears:** Brown bears depend on coastal streams, beaches, mudflats, and river mouths during the summer and fall for catching salmon, clams, and other food sources. If an oil spill contaminates beaches and tidal flats along the Alaska Peninsula coast, some brown bears are likely to ingest contaminated food sources such as clams and carrion (such as dead oiled birds and sea otters). Such ingestion could result in the loss of at least a few to several brown bears.

An oiling experiment on captive polar bears indicated that if a bear's fur becomes contaminated with oil and the bear ingests considerable amount of oil while grooming, kidney failure and other complications could lead to the death of contaminated bears or possible death of bears that consume contaminated food (Oritsland et al., 1981). Brown bears on the Shelikof Strait coast of Katmai National Park (an area contacted by the EVOS) were observed with oil on their fur and were consuming oiled carcasses (Lewis and Sellers, 1991). A study of the exposure of Katmai National Park (Katmai Bay area) brown bears to the EVOS through analysis of fecal samples indicated that some bears had consumed oil or were exposed to oil, and that one young bear that died had high concentrations of aromatic hydrocarbons in its bile and might have died from oil ingestion (Lewis and Sellers, 1991). By the time the EVOS reached Shelikof Strait and contacted the coast of Katmai Bay area, most of the oil was highly weathered and probably had low levels of highly toxic aromatic hydrocarbons. If a large oil spill occurred within Cook Inlet or Shelikof Strait, the oil that might contact habitats frequently used by bears would be fresher and more toxic than the weathered oil from the EVOS that had contacted the area in 1989. An oil spill that originates in lower Cook Inlet/Shelikof Strait and contacts high-use habitats of brown bears during the spring would be expected to have a more serious effect on brown bears than the EVOS.

(c) **Effects on Coastal River Otters:** River otters use coastal beaches and tidal flats and nearshore marine waters for feeding and movements. Oil contamination of these habitats could contaminate locally important food sources and expose these furbearers to direct oiling and oil ingestion through grooming and consumption of contaminated prey and oiled carrion. River otters probably are the most vulnerable terrestrial mammal species to direct oiling, because they spend considerable time feeding in coastal marine waters as well as foraging along the shoreline. River otters probably are similar in sensitivity as sea otters are to loss of thermal insulation because their fur-pelage plays as important a role in body insulation as it does in sea otters (Tarasoff, 1974). River otters also are very likely to ingest oil that has contaminated their fur. River otters were reported to have died from oil ingestion after contact with an oil spill (Baker et al., 1981). Autopsy information on river otters that died in association with the EVOS indicated that the animals probably died from oil ingestion and oil-vapor inhalation through grooming their fur and through ingestion of contaminated prey, such as mussels and clams (Faro, Bowyer, and Testa, 1991). Evidence of tissue damage and hemolytic anemia (indicated by significantly elevated hepatoglobin levels) and significant reduction in body mass, reduced diet diversity, avoidance of preferred habitats, and increased home ranges were evidence of chronic and delayed oil exposure (oil-ingestion-inhalation) effects from the EVOS on river otters in Prince William Sound (Bowyer et al., 1993; Duffy et al, 1993; Faro, Bowyer, and Testa, 1991).

(2) Site-Specific Effects of Oil Spills: Oil and gas development is assumed to occur in the lower Cook Inlet area, with the oil transported from three production platforms by one 125-mi-long subsea pipeline to a landfall facility located at Nikiski.

The results of the OSRA regarding potential effects on terrestrial mammals and their habitats are as follows. Attention is devoted to spills ≥1,000 bbl, which have a trajectory period of up to 30 days during the summer (April-September). Combined probabilities (expressed as percent chance) of one or more oil spills ≥1,000 bbl occurring and contacting coastal habitats of brown bears, river otters, Sitka black-tailed deer, and other terrestrial mammals are shown in Figure IV.B.1.g-1. The highest estimated chance of occurrence and contact is 2 percent (due to the low oil resources). Coastal habitats on the Alaska Peninsula from Kukak Bay north to about Redoubt Bay (LS's 19 and 21-33) have a 1- to 2-percent chance of one or more spills ≥1,000 bbl occurring and contacting Cape Douglas (LS 22), and Ursus Cove; the coastline of Augustine Island (LS 27); Iniskin, Iliamna, Chinitna, and Tuxedni Bays (LS's 29-32); and Kalgin Island (LS 35) have a 2-percent chance of spill occurrence and contact. On the Kenai Peninsula coast, coastline habitats with some chance of spill occurrence and contact (1%) include the Kalifonsky Beach, Ninilchik, Kachemak Bay, and western Barren Islands areas (LS's 40, 42, 44, and 47, respectively; Fig. IV.B.1.g-1).

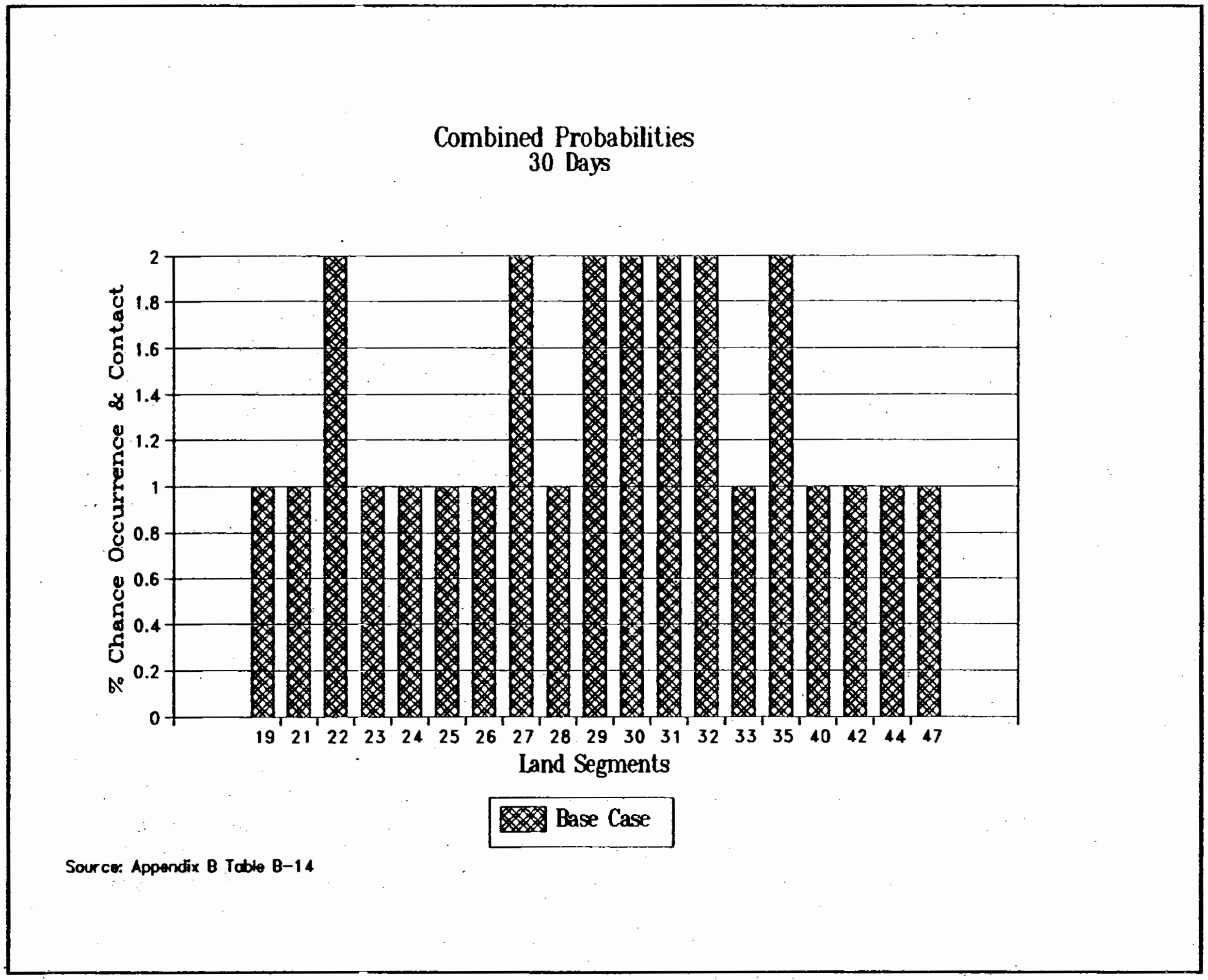
The assumed 50,000-bbl-oil spill may be associated with the assumed offshore oil pipeline or associated with oil-tanker traffic from the Nikiski terminal through Kennedy Entrance into the Gulf of Alaska. Conditional probabilities, as shown in Figure IV.B.1.g-2 for hypothetical pipeline segments P1 through P5, indicate that Tuxedni Bay, Chinitna Bay, Augustine Island, and Cape Douglas have the highest chance (≥19%) of contact (Fig. IV.B.1.g-2, LS's 32, 30, 27, and 22, respectively).

Assuming the spill occurs along hypothetical tanker route T1 through T4 or pipeline route T1 and T2 in lower Cook Inlet, the following coastline habitats—Kalgin Island and Tuxedni and Chinitna Bays—have the highest chances (25, 17, and 16%) of being contacted by a spill in lower Cook Inlet (Fig. IV.B.1.g-3, LS's 35, 32, and 30, respectively). Assuming the spill occurs along hypothetical tanker route T5 through T8 through Kennedy Entrance and into the Gulf of Alaska, the following coastline habitat areas have the highest chance of spill contact: the eastern Barren Islands (11%), Shuyak Island, and north-northeastern Afognak and Marmot Islands (≥5%) (Fig. IV.B.1.g-4, LS's 48 and 77 and 79, respectively).

The spill is most likely to contact coastal habitats on the western shore of lower Cook Inlet (Chinitna or Tuxedni Bays areas) and in the Kachemak Bay or the Ninilchik areas (Figs. IV.B.1.g-1, 2, 3, and 4). Brown bears, river otters, and other terrestrial mammals inhabiting these areas are expected to have some contact with the spill.

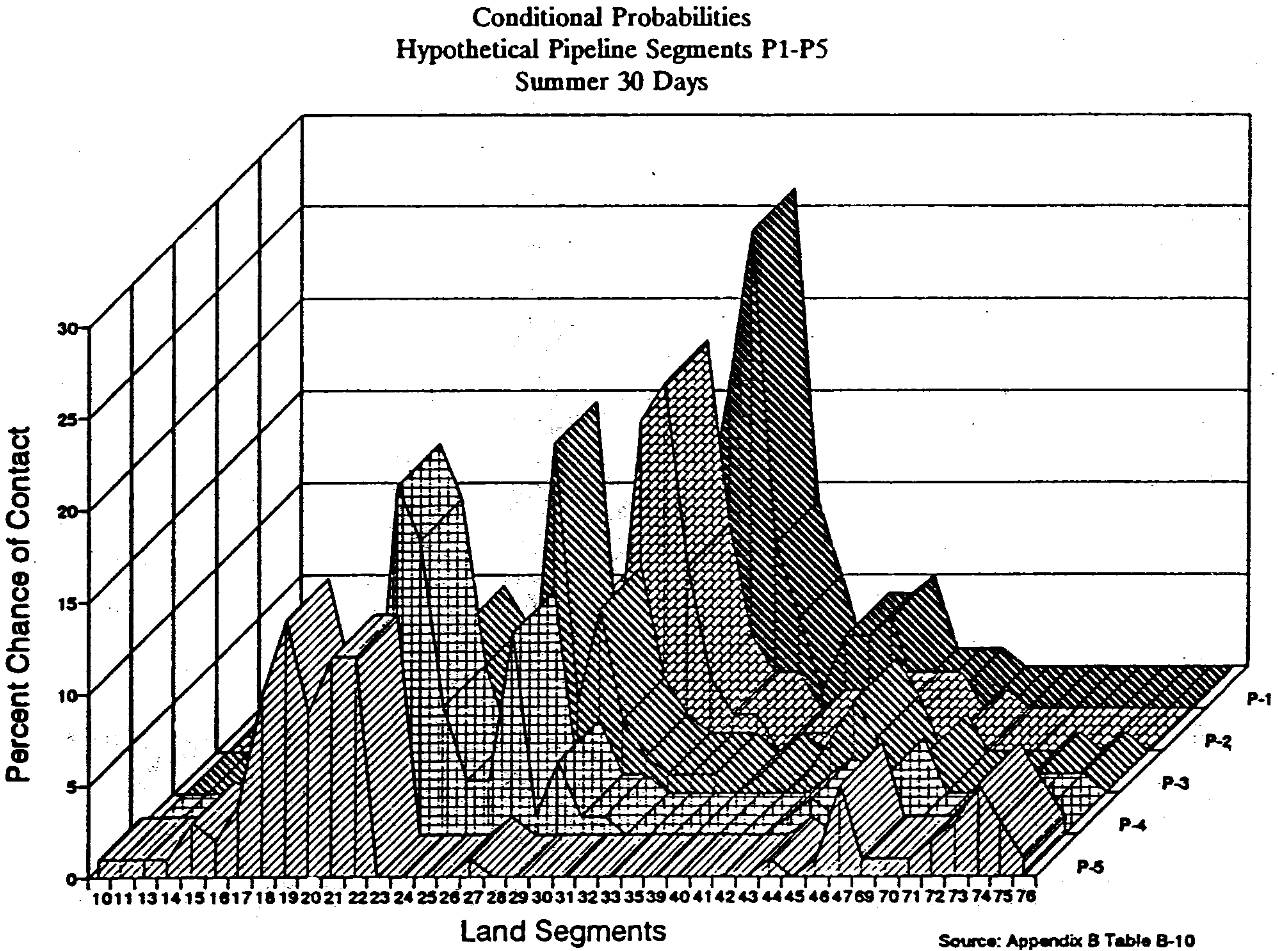
Spills from potential platforms located within about 25 mi east of Chinitna-Iniskin Bays coastal area (LS 29) have an estimated >25-percent chance of contacting this terrestrial mammal habitat area within 30 days during the summer (Appendix B, Fig. B-24, LS 29). Spills from potential platforms located within 20 mi of the Ursus Cove area (LS 28) have an estimated >25-percent conditional probability (expressed as percent chance) of contacting this important brown bear habitat within 30 days during the summer (Appendix B, Fig. B-23, LS 28).

(a) Effects on River Otters: River otters are expected to suffer some direct losses from the oil spill. A number of river otters (perhaps ≤50) are expected to be directly killed by the spill. However, more river otters (perhaps as many as ≥110 based on 0.8 otters per kilometer of coastline [Bowyer et al., 1993] times 140 km of oiled coastline from the assumed 50,000-bbl spill) that inhabit coastal habitats that become oiled are expected to ingest oiled mussels and other oiled intertidal prey organisms. This exposure is expected result in changes in habitat use and reduced diversity in food-source availability, leading to decreased body growth and fitness in coastal otters that are continually exposed to contaminated prey. These effects are expected to persist for >1 year for otters inhabiting areas where food sources remain contaminated. However, the effects on otters are expected to be local (within a portion of the estimated 140 km of oiled shoreline estimated from the 50,000-bbl spill) within habitats where intertidal prey organisms remain contaminated for >1 year (perhaps 3 years).



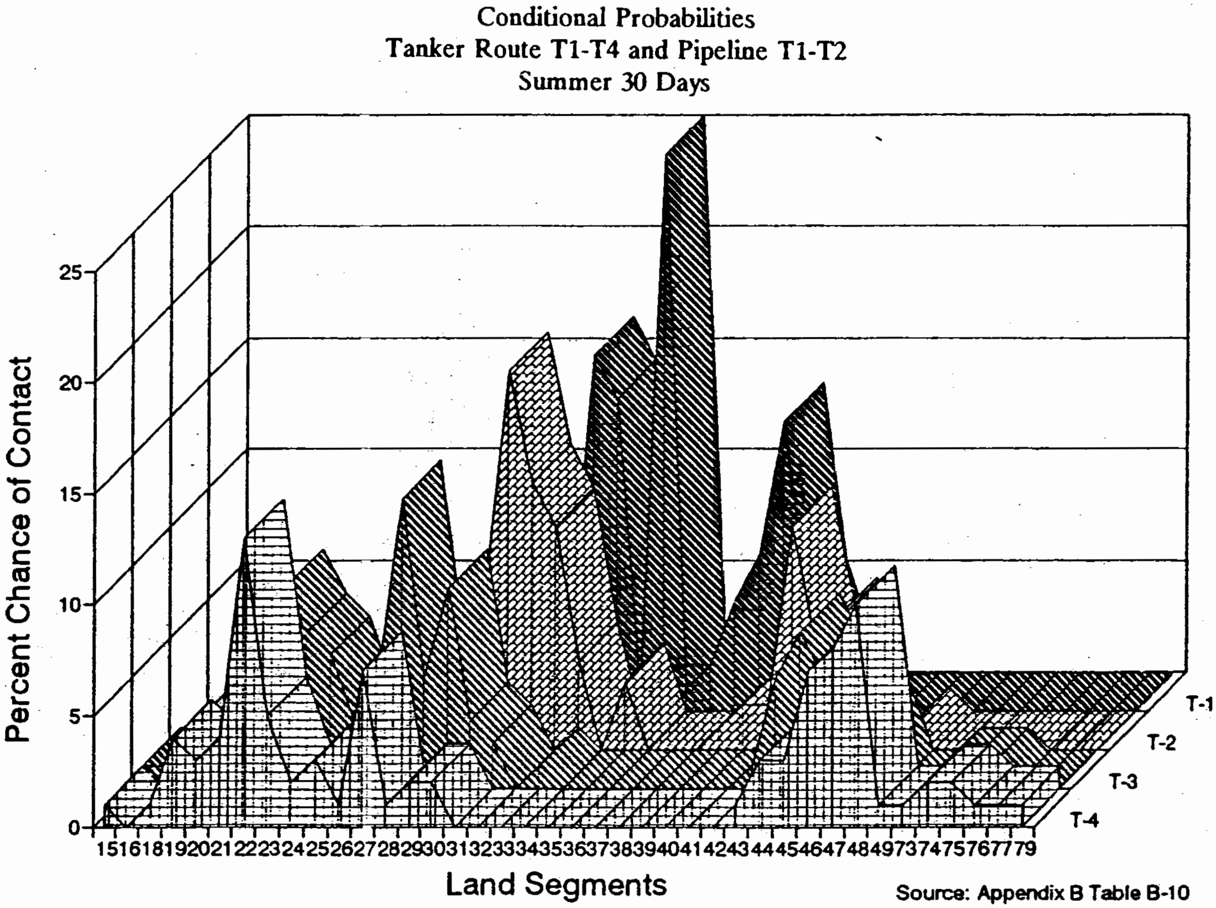
Source: Appendix B Table B-14

Figure IV.B.1.g-1. Combined probabilities (expressed as percent chance), of One or More Oil Spills ≥1,000 Barrels Occurring and Contacting Certain Land Segments within 30 Days Over the Assumed Production Life of the Sale 149 Area.



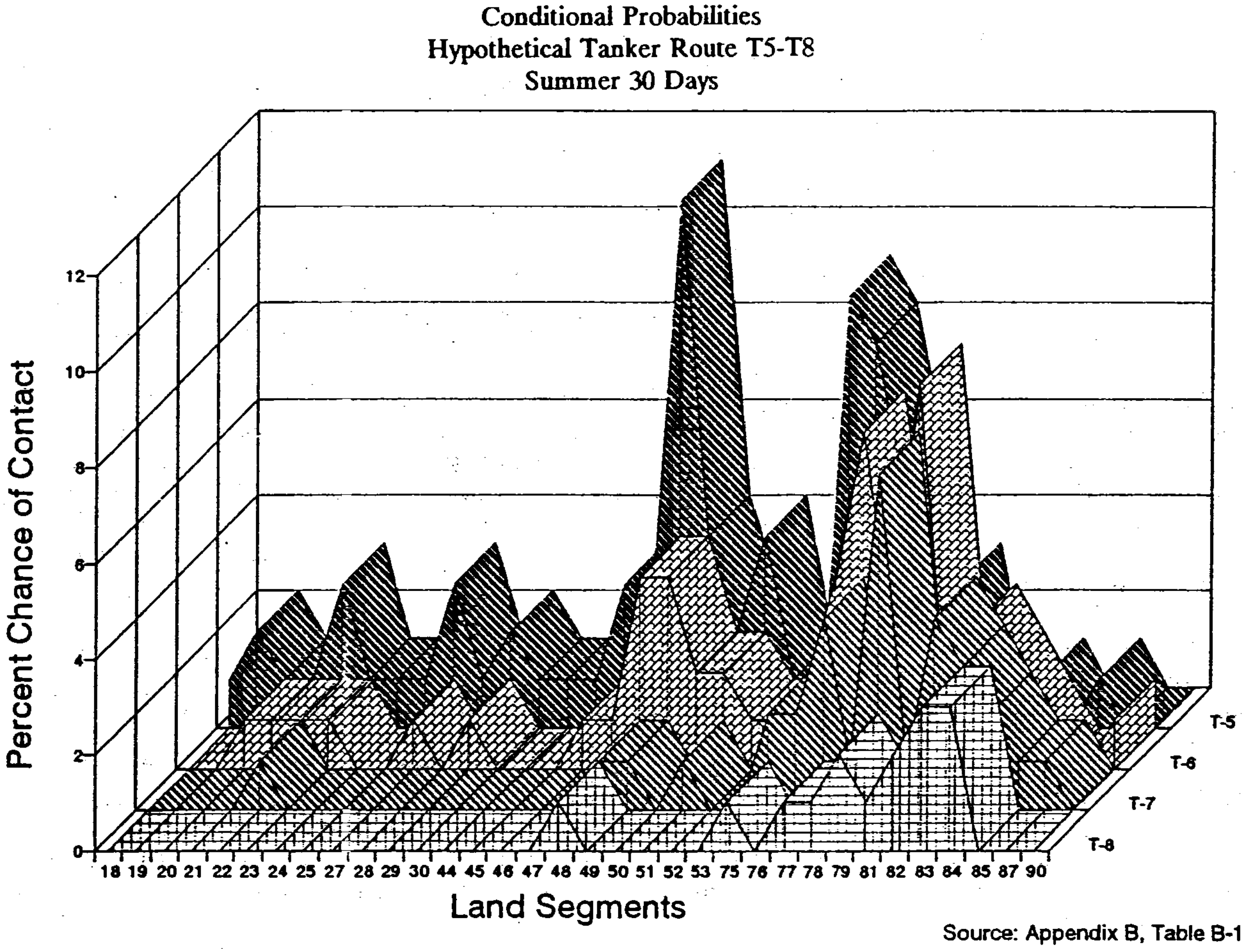
Source: Appendix B Table B-10

Figure IV.B.1.g-2. Conditional Probabilities (expressed as percent chance) that During the Summer Season, an Oil Spill Starting at a Hyothetical Spill Location (Pipeline Segments P1-P5) Will Contact Certain Land Segments Within 30 Days.



Source: Appendix B Table B-10

Figure IV.B.1.g-3. Conditional Probabilities (expressed as percent chance) that During the Summer Season, an Oil Spill Starting at a Hypothetical Spill Location (Tanker Route T1-T4 and Pipeline T1-T2) Will Contact Certain Land Segments Within 30 Days.



Conditional Probabilities
Hypothetical Tanker Route T5-T8
Summer 30 Days

Source: Appendix B, Table B-10

Figure IV.B.1.g-4. Conditional Probabilities (expressed as percent chance) that During the Summer Season, an Oil Spill Starting at a Hypothetical Spill Location (Tanker Route T5-T8) Will Contact Certain Land Segments Within 30 Days.

(b) **Effects on Brown Bears**: Brown bears are expected to be affected primarily through ingestion of oil-contaminated prey (such as mussels and clams) and carrion. A small number of bears (perhaps ≤10) are expected to be killed due to contact with the spill (ingesting oil through grooming of oiled fur or ingesting heavily oiled prey). Assuming that important brown bear spring-concentration areas in the Chinitna Bay and Ursus Cove areas were heavily oiled by the spill, some portion of the brown bear population (perhaps ≥30 bears) that use this habitat during the summer are expected to ingest oiled clams or other intertidal prey organisms from contaminated intertidal sediments (mudflats and saltmarshes) for a number of years after the spill. This ingestion is expected to have sublethal effects on the fitness of some bears and might contribute to a decline in survival of exposed bears. However, neither these sublethal effects nor the direct loss of bears to the spill (perhaps 10 bears) are expected to have population-level effects on brown bears in the sale area.

(c) **Effects on Sitka Black-Tailed Deer**: Sitka black-tailed deer are not expected to be greatly affected much by oil exploration and development because industrial activities and potential oil spills are not expected to significantly contact this species' habitats on Kodiak and Afognak Islands. Combined probabilities of one or more ≥1,000 bbl spills occurring and contacting these habitats are <0.5 percent. However, if a tanker (T5-T8 in Fig. IV.B.1.g-4) or pipeline (P1-P5 in Fig. IV.B.1.g-2) spill occurred along hypothetical routes near Afognak and Shuyak Islands, some (perhaps ≤100) deer are expected to be exposed to the spill if it contaminates kelp or other forage used by the deer during the winter season. Chances of an assumed pipeline or tanker spill (P5 or T5) contacting Afognak and Shuyak island habitats of the deer during winter season are similar to the chances of contacting these habitats during the summer season (Appendix B, Tables B-10 and B-13). Deer that ingest unweathered, highly toxic oil that adheres to kelp or other vegetation are expected to suffer lethal effects, while other deer that ingest weathered oil on plants are expected to experience reduced fitness and survival. However, the number of deer killed or seriously affected by the oil (perhaps ≤100) are expected to be replaced by population recruitment within 1 year.

A total of 47 small oil spills <50 bbl and 2 spills ≥50 bbl but <1,000 bbl also are assumed to occur under the base case. These minor spills are expected to have an additive effect on river otters and other terrestrial mammals, perhaps increasing losses by a few otters and increasing habitat contamination by perhaps 1 percent.

(3) **Effects of Noise and Exploration Disturbance**: For exploratory drilling under the Sale 149 proposal, one drilling unit is expected to be used each year. Some brief (perhaps a few minutes to less than 1 hour) displacement of brown bears, moose, and other terrestrial mammals on the Kenai Peninsula could occur because of noise and movement of aircraft traffic (60 helicopter flights/month) between the Kenai/Nikiski area and the drill platform located in the lower Cook Inlet area and due to marine-vessel-support traffic (30 supply boats/month) between the drill platforms and a marine-support facility in the Kenai area. These effects are expected to be local, within about 1 mi of the aircraft- and boat-traffic routes and have no lasting effect on bears, or other terrestrial mammals.

(4) **Effects of Development Noise and Disturbance**: During oil- and gas-field development, aircraft and supply-boat traffic to and from the three production platforms is expected to increase to 60 to 120 helicopter trips per month and the marine-supply-boat traffic to and from the platform to 60 vessel trips per month. This traffic is expected to increase the frequency or potential disturbance of bears, moose, and other terrestrial mammals along the traffic routes when nearshore. However, the disturbance events are expected to be brief (a few minutes or <1 hour), and the displacement of bears and other terrestrial mammals is expected to last for <1 hour, with no lasting effect on the individual animals. The number of animals displaced is expected to be few (such as 1-3 bears).

Summary: Noise and disturbance effects from air (60-120 helicopter trips/month) and marine-vessel (60 boat trips/month) traffic are expected to have short-term- (a few minutes to <1 hour) displacement effects on brown bears, moose, and other terrestrial mammals within about 1 mi of the traffic routes when nearshore. The assumed 50,000-bbl-oil spill is expected to result in the loss of a small number of river otters (perhaps ≤60), a small number of brown bears (perhaps ≤10), and some Sitka black-tailed deer (<100). More river otters (≥100) and brown bears (perhaps ≥30) are expected to be affected by the spill through contamination of intertidal habitats and prey, with this effect lasting for >1 year (perhaps 3 years). The possible loss of deer from the spill is expected to be replaced by population recruitment within about 1 year. Regional populations of river otters, brown bears, Sitka black-tailed deer, and other terrestrial mammals are not expected to be affected by the oil spill or by the overall effect of exploration and development activities associated with the proposal.

The ITL No. 1, Information on Bird and Mammal Protection, is expected to reduce noise and disturbance effects of air and vessel traffic on terrestrial mammals occurring along the coast of the sale area indirectly through this measure's recommended air- and vessel-traffic distances to avoid disturbance of marine and coastal birds and marine mammals that generally use many of the same coastal habitats as terrestrial mammals. This measure is expected to prevent frequent disturbance of terrestrial mammals from air and vessel traffic along the coast of the sale area. However, on occasion, air traffic is expected to disturb individual brown bears or females and cubs and other terrestrial mammals. This effect is expected to be short term and local and is not expected to affect terrestrial mammal populations. Other stipulations that are part of the proposal and other proposed mitigating measures (see Sec. II.H) are not expected to provide any additional protection for terrestrial mammals nor reduce potential adverse effects.

Conclusion: The overall effect on terrestrial mammals is expected to include the loss of small numbers of river otters (<50), brown bears (<10), and Sitka black-tailed deer (perhaps ≤100) directly killed by the assumed 50,000-bbl-oil spill, assuming contact (combined probability ≥1% to contact specific land segments) to coastline habitats. Total recovery of river otters and perhaps brown bears and their habitats is expected to take >1 year (perhaps 3 years), while the potential loss of Sitka black-tailed deer is expected to be replaced within 1 year. Regional populations of brown bears, river otters, black-tailed deer, and other terrestrial mammals are not expected to be affected by the oil spill or by the exploration and development activities.

h. Effects on the Economy: Increased employment is the most significant economic effect generated by the Alternative I base case. Employees would work on the construction, operation, and servicing of facilities associated with the sale. These facilities are described in the estimated and assumed scenario, Table II.A-1, for the base case and are 2 exploration wells in 1977 and 1 in 1998, 2 delineation wells in 1997 and 3 in 1998, 1 exploration/delineation rig each year in 1997 and 1998, 1 production platform each year in 1999, 2000, and 2001, 10 production/service oil wells in 2000, 20 production/service oil wells in 2001, 18 production/service oil wells in 2002, 1 production rig in 2000, 2 production rigs each year in 2001 and 2002, 1 shore base constructed between 1997 and 2001, and 125 mi of offshore pipeline in the year 2002. Also generating employment would be the production of 200 MMbbl of oil.

For the base case, direct OCS resident employment on the western side of the Kenai Peninsula would start with about 324 in 1997 and 1998; rise to about 694 in 1999 and to about 1,154 in 2000 and about 1,463 in 2001; drop to about 1,320 in 3002; drop to about 849 in 2003; and vary between about 834 and 849 through 2020. Indirect resident employment is estimated to be 12.6 percent of direct OCS-resident employment and would peak at about 184 for the year 2001. (See Appendix G for a description of methodology for employment and population forecasts.)

Most initial workers are anticipated to come from outside the region; some may come from inside the region. The rate of unemployment in the region at the time of demand for OCS workers will be important in determining the ratio of local to outside workers. It is anticipated that in at least the early years of OCS activity for the base case, many workers trained in oil-industry skills would be living on the Kenai Peninsula. Many would have worked on the North Slope or in Cook Inlet. The availability of workers experienced in the oil industry and living on the Kenai Peninsula—when demand for this type of labor is generated by Sale 149—would be determined by the unemployment among them.

It is assumed in the base case that there would be no enclave employment, and that all workers would reside on the western side of the Kenai Peninsula. However, for peak years of development it is assumed that approximately half the workers would be housed in temporary quarters provided by the OCS lessee. Resident employment on the western side of the Kenai Peninsula is estimated to be 15,986 for 1995 and is projected to rise 0.9 percent annually without the sale. Between the years 1997 and 2002, annual increases and decreases in OCS direct and indirect employment would be between zero and 3 percent of total employment each year.

The OCS activity could generate effects on other facets of the economy including income, prices, and taxes. The OCS workers are likely to earn relatively high wages compared to the average income on the western part of the Kenai Peninsula. Even assuming that the income of the OCS workers was twice as high as the average for the western Kenai Peninsula, the effect on the average income would be to change it by <3 percent for <5 years. This is because the largest rise for 1 year in direct OCS employment is 370 workers in 1999 compared to resident employment of 16,422 in 1998.

The <3-percent rise in average income for <5 years is the basic economic driving force of price inflation. The maximum rise in resident employment of <3 percent for 1 year, even assuming that the average income is twice the average for the KPB for 694 direct OCS workers, translates to price inflation of <3 percent for <5 years for the western Kenai Peninsula. Approximately half of the inflationary pressure will be in the demand for housing brought on by the fast rise in OCS workers with relatively high incomes. This inflationary pressure is lessened significantly by the assumption that about half the construction workers will be housed in temporary quarters. After 2 years of exploration and delineation (1997-1998), there are 3 years (1999-2001) of construction of the shore base and pipelines, installation of the platforms, and drilling of the wells. This brings a large spike in OCS employment in the period 1998 to 2003. The projected number of OCS workers for the base case rises precipitously from 324 in 1998 to 1,463 in 2001 and drops to 849 in 2003, at which level it remains to the year 2020. Because housing would be needed for the large number of OCS workers in the exploration and development phases for a relatively short period—5 years—it is assumed that temporary housing would be provided by OCS lessees for approximately half of the OCS workers in these peak years. The year 2000 would have the highest number of OCS workers—1,463; and temporary housing would be provided for about 730 OCS workers and permanent housing for the other 730 OCS workers.

Revenue from property tax would increase <2 percent for <5 years for the Kenai Peninsula Borough (KPB). The value of taxable improvements to property during a peak year is estimated to be $50 million (1993 dollars), which is 1.6 percent of the total taxable valuation for the KPB in 1993 (Barnes, 1993, personal comm.). Primary components of taxable improvements are improvements in existing facilities equivalent to a new shore base and new housing for workers. These would be constructed primarily in the years 1997 to 2001. It is assumed that 200 permanent housing units would be built for each year for the 4 years following exploration, 1999 to 2002. At an average value in 1993 dollars of $100,000 per housing unit, the average value of new housing per year would be $20 million. The value of improvements to shore-base facilities is estimated to be $30 million (1993 dollars) for the peak year.

Annual property-tax revenue of $2.2 million would accrue to the KPB and $0.4 million (1993 dollars) to the State after all major improvements are constructed or installed, which would be 2002. The improvements are estimated to be $100 million for shore-base improvements and $80 million for 800 new housing units. The $180 million of improvements at the rate of 12 mills results in property-tax revenue of $2.2 million. The mill rate of 12 is the approximate average of the mill rates for seven tax-code areas between Anchor Point and Nikiski; the mill rate accruing to the State of Alaska for oil facilities in this case is 8 (Alt, 1993, personal comm.). It is assumed that half of the shore-base improvements are oil facilities.

If the KPB had a sales tax during the period of OCS activity, the expenditures by direct OCS workers and indirect workers would translate to a maximum sales-tax revenue change of <15 percent for <5 years. This is because the sales-tax revenue would be in proportion to the increase in total income for all additional OCS workers in 1 year. It is assumed that the income for OCS workers would be twice that of the average worker for the western Kenai Peninsula.

Headquarters employment is assumed to be located in Anchorage. It would rise from 10 in 1995 to 100 in 2003 to 200 from 2004 through 2012 and drop to 180 from 2013 through 2021. It would result in changes that are <1 percent of Anchorage employment in any given year.

The economic effects of oil spills <1,000 bbl would be very minimal. These small spills would be cleaned up by CISPRI or some similar organization. A spill <1,000 bbl would require <50 person hours to clean up.

The most relevant historical experience in Alaskan waters of a tanker spill of 109,000 bbl (average tanker-size spill, Sec. IV.A.2.a(4)) is the EVOS of 1989, which spilled 240,000 bbl. This spill generated enormous employment that rose to the level of 10,000 workers directly doing cleanup work in relatively remote locations. Smaller numbers of cleanup workers returned in the warmer months each year following 1989 until 1992. Numerous local residents quit their jobs to work on the cleanup at often significantly higher wages. This generated a sudden and significant inflation in the local economy (Cohen, 1993). Anecdotal information indicates that housing rents in Valdez in 1989 increased from 25 percent in some cases to sixfold in others, and inflated rents continued into 1990. Prices of food and other goods increased only slightly, because people could drive to Anchorage to purchase them (Henning, 1993, personal comm.). Research shows that no data on inflation were gathered in a systematic way during the EVOS, although most observers agree that there was temporary inflation.

The number of cleanup workers actually used for a spill associated with Sale 149 would depend to a great extent on what procedures are called for in the oil-spill-contingency plan, how well prepared with equipment and training the entities responsible for cleanup are, how efficiently the cleanup is executed, and how well in reality the coordination of cleanup is executed among numerous responsible entities. A spill resulting from activity associated with Sale 149 could generate half the workers associated with the EVOS, or 5,000 cleanup workers. The combined probability (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting land is . 26 percent within 30 days. Housing rents in the western Kenai Peninsula probably would double for 1 year following a major spill.

Conclusion: The base case would generate changes between zero and 3 percent in resident employment, <3 percent in average income, <5 percent in cost of living, <2 percent in property tax, and <5 percent in sales taxes on the western side of the Kenai Peninsula annually for <5 years. Property-tax revenue of $2.2 million for the KPB and $0.4 million (1993 dollars) for the State would be added annually after the year 2002.

A large oil spill, with a 27-percent probability of occurring, would generate 5,000 cleanup jobs for 6 months in the first year, declining to zero by the fourth year following the spill. Local communities would experience a doubling of housing rents for 1 year.

i. Effects on Commercial Fisheries: The sale area has a large and diverse commercial fisheries (e.g. shellfish, salmon, herring, and groundfish). Recent harvest numbers and values (see Sec. III.C.2) include fishing seasons and vessel and gear descriptions. For purposes of analysis, effects on the commercial-fishing industry associated with the base case are estimated in terms of economic costs and space-use conflicts. Biological effects on the fish themselves have been addressed in Section IV.B.1.c.

(1) Effects on the Shellfish Commercial Fishery: The lower Cook Inlet area supports commercial fisheries for scallops, shrimp, clams, snow crab, and dungeness crab. Formerly, this area also had a commercial fishery for red king crab; however, reduced numbers of this species has forced a regulatory closure.

The commercial shellfish fishery in lower Cook Inlet could be affected by oil spills, drilling discharges, off- shore construction, and seismic surveys. The most threatening of these to any commercial fishery is a large (e.g., 50,000-bbl) oil spill, with both gear and catch at risk. Even if a fishery is not contaminated by oil from a large spill, it could be perceived as being contaminated. This typically leads to fishing closures, the loss of income, and/or marketing problems. In addition to the large oil spill (50,000 bbl) assumed for the base case, a total of 49 small oil spills also are assumed to occur. Due to the relatively small amount of oil involved (555-bbl total), small oil spills are not expected to result in closures or reduced market values over the life of the proposal. However, if a 50,000-bbl spill occurred during a shellfish-fishing season, the Cook Inlet commercial-shellfish industry would be affected by closures. Such a large spill likely would affect immature shellfish in the intertidal zone but not adult shellfish, because they live and are fished for in sub-benthic areas where oil residues seldom reach (Laevastu et al., 1985; also see Secs. IV.B.1-10.b).

Drilling discharges, which affect only a limited area near the drilling platform, are not expected to affect commercial fishing for shellfish. Offshore construction, platforms, and pipelines are expected to infringe to some extent on commercial fishing for shellfish. For the base case, three production platforms are planned. A drilling platform would have little effect on commercial fishing, because it would be expected to foreclose <0.5 km^2 to commercial fishing. This number is based on accepted rules of navigation for avoidance of structures and are not expected to constitute much loss of fishing area. This diversion would cause minimal interference. Seismic surveys may entangle buoy lines for crab pots with consequent loss. To avoid this, these surveys may be conducted during closed fishing periods or seasons, i.e., in summer when pot fisheries are closed. The navigation rules for vessel traffic also serve to avoid potential conflicts.

(2) Effects on Longline Commercial Fisheries: There are longline fisheries for Pacific cod, black cod, and miscellaneous other fish species. Extensive in area and season, these fisheries also could be affected by oil spills, if longline buoylines were fouled by oil or the harvest were tainted by oil. Even without tainting, public perception of such tainting would serve to affect marketing. Some lines and buoys fouled with small amounts of oil may be unfit for future use. Drilling discharges, limited in area and number over time, are expected to have no appreciable effect on longline fisheries of the lower Cook Inlet area. Offshore platforms would foreclose less than a square kilometer to longline fishing, and the presence of an offshore pipeline would not

interfere with longlining. Seismic surveys have the potential to entangle longline buoy lines, especially where this type of gear is highly concentrated. Geophysical-survey contractors may elect to delay surveys where longline fisheries are concentrated to protect their recording gear.

(3) <u>Effects on Trawl Fisheries</u>: The lower Cook Inlet area has trawl fisheries for pollock in the spring and for other finfishes on an intermittent basis during other seasons. The location and timing of trawlers fishing in this area are unpredictable. Oil spills could contaminate trawl gear because they are operated over extensive areas and, depending on catch rate, may operate 24 hours a day. Although it is unlikely that a trawler would be operating in an oiled area, the catch could be contaminated by oil and rendered unsaleable if it were in such an area. As is the case with other fisheries, the market perception of tainting by oil may prove costly to the commercial-fishing industry. Given the estimated area of the assumed base-case oil spill (about 4,000 km^2, Table IV.B.3-1) and the large area typically fished by trawlers, the base-case spill likely would affect trawling. The spill would foreclose more than 4,000 km^2 to trawling.

Drilling discharges, limited in area and number over time (to no more than a 100-m radius from the discharge point) (Jones and Stokes, 1978), are not expected to affect trawl fisheries. Offshore construction, platforms, and pipelines are not likely to significantly interfere with trawling. To avoid the drilling platform, a trawler would need to divert course within 1 mi (1.6 km) of the structure under normal sea conditions and not pass over pipelines. Seismic surveys, planned and coordinated with the commercial-fishing industry, are expected to have a minimal effect on the Cook Inlet commercial-fishing industry.

(4) <u>Effects on Purse-Seine Commercial Fisheries</u>: Purse-seine vessels fish in Shelikof Strait from late spring through the summer annually, with some regulatory closed periods. These vessels harvest herring and salmon and work mainly within State waters. Oil spills could contaminate purse seines and the harvest. A large oil spill in the season when purse-seine vessels are active could force closure of short-period, high-value, commercial fisheries (e.g., sac-roe herring).

Drilling discharges are not expected to affect purse-seine fisheries, because they usually operate some distance from OCS activities. Offshore construction, platforms, and pipelines are not expected to affect the purse-seine fisheries. Seismic surveys employing airguns might exert temporary disturbance/dispersal to fish and thus may reduce the purse-seine harvest. This would be limited to the time of the survey, probably to no more than 1 hour following passage of the airgun array (Pearson, Mokness, and Skalski, 1993).

(5) <u>Effects on Drift-Gillnet Fisheries</u>: Drift-gillnet vessels in the lower Cook Inlet area fish for herring in mid-April through the end of June and for salmon into August. As with other fisheries, an oil spill could damage drift-gillnet gear (primarily floats and floatline). Drilling discharges are not expected to affect the drift-gillnet fisheries. Seismic surveys using airguns to generate acoustic energy could affect the drift-gillnet industry, because seismic noise may disperse herring and salmon and reduce the catch. However, this is likely to be limited to the immediate area of the surveys and to the few hours during survey operations. Because the drift-gillnet industry normally fishes within 3 mi of the beach, seismic surveys associated with the base-case are not likely to affect it. In cases where drift-gillnet fishermen fish farther out in Cook Inlet, space-use conflicts with seismic-survey vessels, exploration-drilling units, and/or production platforms are possible. Nevertheless, seismic surveys that are planned and coordinated with the commercial-fishing industry are expected to make conflicts rare to nonexistent.

(6) <u>Effects on Setnet Fisheries</u>: The bays and beaches of lower Cook Inlet have a number of setnet sites where gillnets are anchored to the beach or slightly offshore, and are used to harvest salmon and herring. These operations could be affected by oil spills but not from offshore discharging, offshore construction, and seismic-survey activities. Oil spills could damage setnet fisheries, as evidenced by the EVOS of 1989. Relatively small volumes of weathered oil entered the lower Cook Inlet region, yet the commercial salmon fishery was closed to protect both gear and harvest from possible contamination. Because the entire base-case oil spill (50,000 bbl) would occur in Cook Inlet, it is likely to result in the area being closed to commercial fishing for a longer period than it was for the EVOS. Hence, the assumed base-case oil spill is likely to have a greater overall effect on the commercial-fishing industry in lower Cook Inlet than the EVOS did.

(7) <u>Effects on Pot Fisheries</u>: Crab-pot fisheries would be at hazard from oil spills contacting buoys and buoy lines, as well as from seismic and other vessel traffic that could entangle and damage

crab pots. Drilling discharges and offshore construction likely would have no effect on either the gear or the fishery. Seismic vessels have interfered with this type of commercial-fishing gear before; however, cooperation between the seismic-survey industry and the commercial-fishing industry has minimized these space-use conflicts. Additionally, commercial fishermen may be compensated for any gear loss or damage attributable to offshore oil and gas operations.

(8) Economic Effects of the Base Case on the Commercial-Fishing Industry: As discussed above, drilling discharges, offshore construction, and seismic surveys associated with the base case are not expected to have a measurable effect on commercial fishing. The primary factors affecting the Cook Inlet commercial-fishing industry are those from a large oil spill (resulting in possible closures) and space-use conflicts. Due to the relatively small amount of oil involved (555-bbl total), the 49 small oil spills (Table IV.A.2-4d) assumed for the base case are not expected to result in closures or reduced market values over the life of the proposal. Hence, they are not expected to have a measurable economic effect on the Cook Inlet commercial-fishing industry. This section estimates the economic costs to the Cook Inlet commercial-fishing industry that could result from the assumed (50,000-bbl) base-case oil spill. (Economic costs are defined as any measurable cost associated with reduced catches [e.g., closures due to an oil spill], reduced market value, gear loss, or any measurable increased cost due to the proposal.) The estimated effect of space-use conflicts (related or unrelated to the spill) associated with the base case is incorporated into the estimate of economic costs.

The economic cost of a major oil spill to the commercial-fishing industry is typically due to closures, tainting (real or perceived), and gear contamination. Due to the lack of data concerning these individual components, the following estimate of economic costs to the Cook Inlet commercial-fishing industry is based on the two oil spills that provide the most insight in this regard, the EVOS and the *Glacier Bay* oil spill (GBOS). However, it should be noted that the information concerning these two spills suggests that similar methods of economic analysis were not used. For example, the EVOS was analyzed based on agency reports and modeling efforts; the analysis of the GBOS was based primarily on interviews with processors and commercial fishermen. Further, much of the information needed for the analysis of these two spills either was missing, incomplete, or withheld. Hence, the following estimate of economic costs to the commercial-fishing industry of Cook Inlet is limited by these same factors.

The EVOS was a 240,000-bbl oil-tanker spill that occurred in Prince William Sound on March 24, 1989, just prior to the commercial-fishing season. The ex-vessel losses following the EVOS were estimated to have ranged between $6.4 and $41.8 million in 1989 and $11.1 to $44.5 million in 1990. These estimates are based on economic modeling and have a wide range due to the variability of natural and economic conditions that affect the value of the fisheries. However, the financial compensation received by the commercial-fishing fleet during the cleanup process was not factored into these estimates. That compensation was estimated to have exceeded, by several orders of magnitude, the revenue lost due to the spill (Cohen, 1993). Although participation in the EVOS cleanup and compensation to individual commercial fishermen was not evenly distributed, some fishermen received substantial compensation while others received little or none.

The GBOS was a 4,000-bbl oil-tanker spill that occurred in upper Cook Inlet on July 2, 1987, during the commercial-fishing season. The estimated economic losses associated with this spill were based primarily on discussions with driftnet and setnet salmon fishermen. Although losses experienced by processors would have been an important component in the overall commercial-fishing-industry analysis, they did not provide the necessary information to be included in the analysis. Losses reported by driftnet fishermen ranged from about $10 to $108 million, and from $12 to $82 million for setnet fishermen (USDOI, MMS, Herndon, 1990).

From the above, it can be seen that the two spills differed greatly in size (EVOS, 240,000 bbl vs GBOS, 4,000 bbl). However, due to the distance to Cook Inlet from the EVOS spill site, very little of the EVOS oil actually reached Cook Inlet; and what did enter Cook Inlet was heavily weathered. Another major difference between the two spills is the type of fishery that exists in the two areas. The EVOS affected primarily a herring and pink salmon fishery in Prince William Sound; whereas, the GBOS had its primary effect on a king and sockeye salmon fishery in Cook Inlet (the one of primary interest for this analysis). Nevertheless, the availability and reliability of the EVOS economic-loss data appear to have been better than those of the GBOS. Hence, it is apparent the there are valid reasons for incorporating the information from both the EVOS and the GBOS into an estimate of the economic effects of the assumed base-case oil spill on commercial fishing.

The entire Cook Inlet fishery for all species (salmon, herring, groundfish, and shellfish) is estimated to have an ex-vessel value of $50 to $135 million, depending on the price/year and numbers caught. From the estimated value of the Cook Inlet fishery, it appears that the upper-loss estimates from the GBOS (due mostly to closures) provided by Cook Inlet salmon fishermen are unrealistically high ($190 million). Such a loss would have effectively eliminated the entire Cook Inlet fishery for that year with only a 4,000-bbl spill, which it did not. Because the assumed base-case-oil spill (50,000 bbl) is about 12 times the size of the GBOS spill (4,000 bbl), the Cook Inlet fishery effectively would be wiped out by the base-case spill many times over using the upper-loss estimates. However, the EVOS was about 60 times the size of the GBOS and only resulted in maximum loss estimates of about $40 to $45 million/year for the 2 years following the spill. For these reasons, the EVOS loss estimates are used in this analysis rather than the GBOS estimates.

Because the assumed base-case-oil spill (50,000 bbl) is about five times smaller than the EVOS (240,000 bbl), it could have (depending on closures) less of an effect on the Cook Inlet commercial-fishing industry than the EVOS did in Prince William Sound. However, it is more likely that a 50,000-bbl spill in Cook Inlet would deposit more oil (particularly fresh oil) in Cook Inlet than the EVOS did. Hence, in this analysis it is assumed that the 50,000-bbl-oil spill has an equal economic effect as that of the EVOS, and that it occurs at the beginning of the Cook Inlet commercial fishing season. If the Cook Inlet and Prince William Sound commercial fisheries are assumed to be of similar value, the base-case-oil spill is estimated to result in economic losses to the Cook Inlet commercial-fishing industry of about $18 million (the sum of the lower 2-year EVOS loss estimates) to about $86 million (the sum of the higher 2-year EVOS-loss estimates) (Cohen, 1993). Hence, the assumed base-case-oil spill is estimated to result in an economic cost of about $9 to $43 million/year for 2 years.

From 1983 to 1993, the value of the Cook Inlet commercial fishery appears to have ranged between about $50 and $135 million. Based on the above, in any 2-year period when the value of the Cook Inlet commercial fishery is estimated to be about $50 million/year, a 2-year loss of about $9 million/year represents a 18-percent/year loss for 2 years. A 2-year loss of about $43 million/year represents a 86-percent/year loss for 2 years. In a 2-year period when the annual value of the Cook Inlet commercial fishery is estimated to be closer to $135 million, a 2-year loss of about $9 million/year represents a 7-percent/year loss for 2 years; whereas a 2-year loss of $43 million/year represents a 32-percent/year loss for 2 years.

The above examples illustrate the effect of maximum ($43 million) and minimum ($9 million) EVOS loss estimates to the Cook Inlet commercial-fishing industry for minimum ($50 million) and maximum (135 million) income years. However, because the assumed 50,000-bbl-oil spill would preclude any knowledge of what the commercial fishery would have been worth had the spill not occurred, the value of the commercial fishery for the years affected by the spill is assumed to be the average annual value of the Cook Inlet commercial fishery. (The average annual value of the Cook Inlet fishery is based on as yet unpublished ADF&G information for 1983-1993.) In terms of the average annual value (about $65 million), a 2-year loss of about $9 million/year represents a 14-percent/year loss for 2 years; whereas a 2-year loss of about $43 million/year represents a 66-percent/year loss for 2 years.

Thus, based on EVOS loss estimates and the annual value of the Cook Inlet commercial fishery, the assumed 50,000-bbl-oil spill could result in an economic loss to the Cook Inlet commercial-fishing industry of 7 to 86 percent/year for 2 years. However, in terms of the average annual value of the Cook Inlet commercial fishery, the assumed 50,000-bbl-oil spill is more likely to result in a loss of about 15 to 65 percent/year for 2 years.

From 1981 to 1989, the estimated average annual value of the Kodiak commercial-fishing industry was somewhat higher than that of the Cook Inlet commercial-fishing industry (about $75 million). Although lows and highs only range from $50 to $100 million/year, Kodiak appears to maintain a higher average annual commercial-fishing income than the Cook Inlet area. However, less than half of the Kodiak commercial-fishing income is derived from fishing in the Shelikof area, which is the only area around Kodiak island likely to be contacted by a large oil spill originating in Cook Inlet. Hence, based on the description above of estimated Cook Inlet losses, estimated losses to the Kodiak commercial- fishing industry are expected to be less than half of that estimated for Cook Inlet, or about 5 to 25 percent/year for 2 years following the assumed large Cook Inlet oil spill. This amounts to an estimated loss of about $4 (.05 x 75 = 3.75) to $19 (.25 x 75 = 18.75) million/year to the Kodiak commercial-fishing industry. Based on the EVOS experience, compensation to the commercial-fishing industry for participating in the cleanup of an oil spill is likely to exceed these economic losses by several orders of magnitude.

Section IV.B.1.h, Economy, has additional analysis concerning effects on commercial-fisheries employment.

Summary: Drilling discharges associated with the base case are not expected to affect commercial fishing due to the limited area affected near the platform-discharge point. Offshore construction, platforms, and pipelines are expected to result in some space-use conflicts (e.g., competition for docking space or gear loss); however, these are expected to be few in number and minor in scope. Seismic surveys, planned and coordinated with the commercial-fishing industry, are expected to have a minimal effect on the Cook Inlet commercial-fishing industry. Due to the relatively small amount of oil involved (555 bbl), the 49 small oil spills assumed for the base case are not expected to result in closures, or reduced market values over the life of the proposal. Hence, they are not expected to have a measurable economic effect on the Cook Inlet commercial-fishing industry. However, the assumed large (50,000 bbl) base-case oil spill is expected to affect pot, longline, trawl, drift-gillnet, and set-gillnet fisheries in Cook Inlet.

The estimated economic effect of the base-case oil spill on the Cook Inlet commercial-fishing industry is based on what occurred during the EVOS and GBOS, and primarily depends on the highly variable EVOS cost estimates (ranging from $9-43 million/year for 2 years). From 1983 to 1993, the value of the Cook Inlet commercial fishery appears to have ranged between about $50 and $135 million/year. Based on the above, in any 2-year period when the value of the Cook Inlet commercial fishery is estimated to be about $50 million/year, a 2-year loss of about $9 million/year represents an 18-percent/year loss for 2 years; whereas a 2-year loss of about $43 million/year represents an 86-percent/year loss for 2 years. In a 2-year period when the value of the Cook Inlet commercial fishery is estimated to be closer to $135 million/year, a 2-year loss of about $9 million/year represents a 7-percent/year loss for 2 years; whereas a 2-year loss of $43 million/year represents a 32-percent/year loss for 2 years. However, because the occurrence of a large oil spill would preclude any knowledge of what the commercial fishery would have been worth, the value of the commercial fishery at the time of the assumed 50,000-bbl-oil spill is assumed to be the average annual value (1983-1993) of the Cook Inlet commercial fishery. In terms of the average annual value of the Cook Inlet commercial fishery (about $65 million), a 2-year loss of about 15 to 65 percent/year is more likely. Estimated losses to the Kodiak commercial-fishing industry are expected to be less than half of that estimated for Cook Inlet, or about 5 to 25 percent/year for 2 years following the assumed 50,000-bbl Cook Inlet oil spill. This amounts to an estimated loss of about $4 to $19 million/year to the Kodiak commercial-fishing industry. Based on the EVOS experience, compensation to the commercial-fishing industry for participating in the cleanup of an oil spill is likely to exceed these economic losses by several orders of magnitude.

Mitigating measures that would have the most effect on commercial fisheries include the stipulation on the Protection of Fisheries, the potential stipulation on Restriction on Multiple Operations, and the ITL on Oil Spill Response Preparedness. With these mitigating measures in place, there is an increased probability that (1) conflicts between the oil/gas industry and Cook Inlet commercial fishing industry (including drift net fishermen) would be minimized and (2) less oil would reach the commercial-fishing grounds following a large oil spill. To the degree that they are implemented, these mitigating measures are expected to benefit the Cook Inlet commercial fishing industry; however, their absence is not expected to substantially increase adverse effects.

Conclusion: Based on the assumptions discussed in the text, the base case is estimated to result in economic losses to the Cook Inlet commercial-fishing industry ranging from about 15 to 65 percent/year for 2 years following the assumed 50,000-bbl-oil spill. Losses to the Kodiak commercial-fishing industry from the same spill are estimated to range from about 5 to 25 percent year for 2 years following the spill. The chance of one or more oil spills ≥1,000 bbl is estimated to be 27 percent.

j. Effects on Subsistence-Harvest Patterns: Section III.C.3 describes the subsistence-harvest patterns for those communities in Southcentral Alaska that potentially could be affected by the base case. The analysis that follows takes into account effects from routine operations, such as seismic surveys, the disposal of drilling muds and cuttings, and construction and other support activities as well as accidental events such as oil spills.

(1) Exploration Phase: The exploration phase of the base case spans a 2-year period, during which eight wells are drilled from a single drilling platform. Site-specific seismic surveys carried out prior to drilling could disturb fish, marine mammals, marine and coastal birds, and marine invertebrates during the open-water periods these surveys are carried out; discharged muds and cuttings also could produce localized effects on marine resources (see Secs. IV.C.2.b-g for discussions of effects on marine resources).

The operation of support and logistic activities for the exploration phase should not increasingly affect subsistence resources or harvests, because such operations are estimated to take place primarily from existing air and marine facilities on the Kenai Peninsula. Supply-boat and helicopter trips between these facilities and the exploration platform could interfere with subsistence harvests as a result of disturbance, but such events should be localized and should be subject to mitigation if consistently encountered. Accidental small oil spills offshore are not expected to contribute to reduced subsistence resources or harvests.

(2) **Development and Production Phase**: The development and production phase of the base case extends for 22 years (1999-2021), during which time three production platforms are installed, 125 mi of pipeline are installed, 48 production and service wells are drilled, and 19 years of production take place to produce an assumed total of 200 MMbbl of oil.

Site-specific seismic surveys carried out prior to locating the production platforms, installing the platforms on station, and drilling the 48 wells could disturb fish, marine mammals, marine and coastal birds, and marine invertebrates during open-water periods (see Sec. IV.C.2.b-g for discussions of effects on marine resources). Installation of the production platforms offshore and the disturbance of the seafloor necessary to install the offshore pipeline would reduce habitat for bottom-dwelling creatures and could reduce locally used subsistence resources. Discharged muds and cuttings from the production platforms also could produce effects on marine resources in the vicinity of the platforms and reduce the availability of such resources.

The operation of support and logistic activities for the 22-year development and production phase should not increasingly affect subsistence resources or harvests because such operations are estimated to take place primarily from existing air and marine facilities on the Kenai Peninsula. Supply-boat and helicopter trips between these facilities and the production platforms could interfere with subsistence harvests as a result of disturbance, but such events should be localized and subject to mitigation if consistently encountered.

Accidental small oil spills offshore (the majority of which are estimated to average 5 bbl) are not expected to reduce subsistence resources or harvests, because such spills present little difficulty in cleanup.

Accidental large oil spills ≥1,000 bbl could affect subsistence harvests. There is a 27-percent chance of one or more spills ≥1,000 bbl occurring in the base case and a 26-percent chance one or more spills ≥1,000 bbl occurring and contacting land after 30 days (Table IV.A.2-2 and Appendix B, Table B-14). Land segments from the OSRA model are used here to represent community subsistence-harvest areas. These land segments correspond as closely as possible with the subsistence-harvest areas mapped in Figures III.C.3-3, 4a and b, and 5. The representations are as follows (see Fig. IV.A.2-2 for land segment identification):

Cook Inlet:	
Tyonek	LS's 32-34, 36-37
Central Kenai Peninsula	LS's 38-40
Southern Kenai Peninsula	LS's 41-44
Nanwalek and Port Graham	LS's 44-46, 49-51
Kodiak and Afognak Islands:	
Akhiok	LS's 67, 88-90, 95-96
Karluk	LS's 67-69, 96
Kodiak road-connected area	LS's 67-90, 94-96
Larsen Bay	LS's 68-70
Old Harbor	LS's 85-90, 95
Ouzinkie	LS's 70-82
Port Lions	LS's 70-81
Alaska Peninsula:	
Ivanof Bay	LS's 1-4
Perryville	LS's 1-7
Chignik Lake	LS's 1-9
Chignik and Chignik Lagoon	LS's 1-12

(a) Cook Inlet: For the Tyonek subsistence-harvest area land segments, the mean number of one or more spills ≥ 1,000 bbl estimated to occur and contact over the assumed 19-year-production life of the lease-sale area in all cases is estimated to be less than one (Appendix B, Table B-14). Land segment 32, representative of the southern extremity of the Tyonek subsistence-harvest area, shows an estimated 2-percent chance that one or more spills ≥ 1,000 bbl would occur and contact within 10 and 30 days. Elsewhere along the shoreline used by Tyonek residents (LS's 33, 34, 36, and 37), the chance of one or more oil spills ≥ 1,000 bbl occurring and contacting land segments ranges from 1 percent (LS 33) within 10 and 30 days to <0.5 percent.

Spills starting at pipeline (P1-P5 and T1 and T2) or tanker segments (T1-T8) are estimated to have a <0.5- to 26-percent chance of contacting the southerly extremity of the Tyonek subsistence resource-harvest area (LS's 32 and 33), within 30 days during summer (assumed April-September) or winter (assumed October-March) (Appendix B, Tables B-10 and B-13). Land segments 32 and 33 generally coincide with the shoreline located south of Harriet Point. Elsewhere along the shoreline used by Tyonek residents (LS's 34, 36, and 37), the chance of spills contacting land from pipeline or tanker segments does not exceed 2 percent. This characteristic of LS 37 indicates a very low chance of oil reaching the main Tyonek subsistence-harvest areas located north of the Sale 149 boundary. These and earlier data suggest that effects on subsistence harvests from oil spills should be limited, because the bulk of the area used for Tyonek subsistence harvests (north of Harriet Point) is estimated to be affected little by oil-spill contact.

On the western and southern shores of the Kenai Peninsula (LS's 38-46 and 49-51), the chance of one or more oil spills ≥ 1,000 bbl occurring and contacting land segments for central and southern Kenai Peninsula communities and for Nanwalek and Port Graham ranges from <0.5 to 1 percent, with land segments for the southern Kenai Peninsula (LS's 42-45) showing a range from <0.5- to 1-percent chance of occurrence and contact within 10 and 30 days. The mean number of one or more spills ≥ 1,000 bbl estimated to occur and contact land over the assumed 19-year-production life of the lease-sale area in all cases is estimated to be less than one (Appendix B, Table B-14).

Land segment 40, located between Kenai and Ninilchik, is the only part of the central Kenai Peninsula shoreline estimated to have more than a 10-percent chance (during summer months) of contact if oil were spilled from a single transportation segment. Elsewhere in the central Kenai Peninsula area (LS's 38, 39), there is estimated to be no more than a 7-percent chance of shoreline contact from a single transportation segment 30 days after a spill during either summer or winter (Appendix B, Tables B-10 and B-13).

Further south along the southern Kenai Peninsula coast, LS's 42 and 44 show no more than a 10-percent chance of contact within 30 days from single transportation segments during summer months, and LS's 43 to 51 (excluding LS's 47 and 48) show some chance of contact from single transportation segments within 30 days during winter months. Except for LS's 42 and 44, there is estimated to be no more than an 8-percent chance of shoreline contact (LS 43) within 30 days from single transportation segments within the area of southern Kenai Peninsula communities during summer or winter months. The chance of contact for the Nanwalek and Port Graham subsistence-harvest area (LS's 44-46 and 49-51) is almost the same, because it also incorporates LS 44, and no other land segment within the Nanwalek and Port Graham subsistence-harvest area exceeds a 7-percent single-source chance of contact. However, two land segments (44 and 45) show chance of contact ≥ 1 percent from as many as 10 transportation segments during summer and the highest chance of contact of 10 percent (LS 44) (Appendix B, Tables B-10 and B-13).

Based on these data for the Kenai Peninsula, subsistence-harvest areas of the central Kenai Peninsula should be least affected by spills. The limited subsistence harvests carried out by central Kenai Peninsula communities therefore should not be affected. Exceptions to this general condition, of course, exist in the central Kenai Peninsula, such as the Kenaitze (Kenai Tanaina) educational net fishery on the Kenai River, which may be affected to a limited extent. On the other hand, the communities of the southern Kenai Peninsula are estimated to be the most affected by spills, where the chances of one or more oil spills ≥ 1,000 bbl occurring and contacting land is the greatest although limited in magnitude. The southern Kenai Peninsula also is shown to be the most affected by a relatively high density of shoreline contacts from transportation segments. The subsistence-harvest area of Nanwalek and Port Graham is shown to be affected similar to the southern Kenai Peninsula but to a lesser extent. Southern Kenai Peninsula communities, as well as Nanwalek and Port Graham, would experience subsistence-harvest losses because of a 1% chance of a 50,000-bbl spill occurring and contacting land segments within community subsistence-harvest areas and the high level of exposure to spills from transportation segments. Such losses would include the lack of resource availability, accessibility, or desirability for use. Reductions in subsistence-harvest levels for specific resources could extend for a year or more.

Guidance on the potential amount of harvest reduction that would be estimated to take place is provided by the EVOS experience (see Sec. III.C.3). Subsistence harvests in the first year following the EVOS were reduced by 50 to 80 percent for the most severely affected communities, with harvest levels for most resources rebounding during the next 2 to 3 years. A 50,000-bbl spill, which is roughly 20 percent of the EVOS, would be expected to produce harvest-level reductions estimated at 30 to 50 percent of average annual yields in the first year, with substantial recovery thereafter.

(b) **Kodiak and Afognak Islands:** Land segments representing Kodiak and Afognak Islands (LS's 67-90 and 95-96) are estimated to have a <0.5 percent chance that one or more spills ≥1,000 bbl would occur and contact within a 30-day period. The estimated mean number of one or more spills ≥1000 bbl estimated to occur and contact land segments over the assumed 19-year-production life of the lease-sale area in all cases is less than one (Appendix B, Table B-14).

Most land segments on Kodiak and Afognak Islands are estimated to have at least a 1-percent chance of being contacted during the summer and winter within 30 days if oil were spilled from transportation segments (P1-P5 and T1-T8) (Appendix B, Tables B-10 and B-13). Land segments 68 through 73, located on the west coasts of Afognak and Kodiak Islands, show chances of contact ranging from <0.5 to 3 percent, with possible contact from two to six transportation segments for any one land segment. Land segments 74 through 79, located at the northerly reaches of Afognak Island, show the highest chance of contact from transportation segments, ranging from <0.5 to 10 percent, with possible contact from 4 to 10 transportation segments for any one land segment. Land segments 80 through 90, located on the east side of Afognak and Kodiak Islands, show chances of contact ranging from <0.5 to 6 percent, with possible contact from two to four transportation segments for any one land segment. Elsewhere on the islands, the chances of contract from transportation segments is <0.5 percent.

The subsistence-harvest area for Ouzinkie and Port Lions (represented by LS's 70-82) is the most heavily contacted by oil spilled from transportation segments, should that occur. However, effects on subsistence harvests in Ouzinkie and Port Lions from spill contacts should be limited due to the large size of the harvest area.

The road-connected Kodiak community uses the entire area of Kodiak and Afognak Islands for subsistence harvests, yet 90 percent of all households use an area represented by LS's 82 through 86 (Zone 1, as shown on Fig. III.C.3-5) for any harvest activities. This area shows a very low estimated chance of contact (≤6%) from transportation spills, should they occur, during summer or winter within 30 days. Because of this, little direct effect on subsistence harvests from spills is expected among Kodiak road-connected residents.

Akhiok (LS's 88-90, 95-96, and 97) and Old Harbor (LS's a 85-90 and 95) use the southern extremities of Kodiak Island for subsistence harvests. This part of Kodiak Island shows a very low (<0.5-3% in winter after 30 days) extent of contact from transportation segments, which suggests a comparable level of reductions on subsistence harvests for these communities. Karluk (LS's 67-69 and 96) and Larsen Bay (LS's 68-70), on the other hand, use a stretch of coast along the southern reaches of Shelikof Strait, which also is contacted to a very low (<0.5-3% in winter after 30 days) extent by oil from transportation segments, should such spills occur. As a consequence, there should be no measurable changes in the availability, accessibility, or desirability of subsistence resources and little change in the amounts of subsistence harvests among these Kodiak Island communities.

(c) **Alaska Peninsula:** On the Alaska Peninsula, LS's 1 through 9 represent the aggregate subsistence-harvest area for Chignik Lake, Ivanof Bay, and Perryville, and LS's 1 through 12 represent the aggregate subsistence-harvest area for Chignik and Chignik Lagoon, with LS 12 located the closest to the lease-sale area. There is a <0.5-percent chance of one or more spills ≥1,000 bbl occurring and contacting these land segments; the mean number of one or more spills ≥1,000 bbl estimated to occur and contact over the assumed 19-year-production life of the lease-sale area in these cases is less than one. The chance of contact from transportation segments is very low, with a high single-source chance of contact of no more than 2 percent after 30 days for LS's 10 through 12. Under these circumstances, there should be no measurable changes in the availability, accessibility, or desirability of subsistence resources and little change in the amounts of subsistence harvests among these Alaska Peninsula communities.

Summary: Effects on subsistence-harvest patterns in the base case would be most prominent among southern Kenai Peninsula communities, including the communities of Nanwalek and Port Graham. These communities would experience subsistence-harvest losses because of a 1% chance of one or more ≥1,000-bbl spills occurring and contacting land segments within community subsistence-harvest areas and the high level of exposure to spills from transportation segments. Such losses would include the lack of resource availability, accessibility, or desirability for use. Based on the EVOS experience (see Sec. III.C.3), harvest-level reductions estimated at 30 to 50 percent of average annual yields could occur in the first year of a spill, with substantial recovery thereafter.

Elsewhere in Cook Inlet and on Kodiak Island and the Alaska Peninsula, effects on subsistence-harvest patterns are estimated to be limited in magnitude and duration and not of such a nature as to cause measurable changes in the availability, accessibility, or desirability of most subsistence resources.

Conclusion: Subsistence harvests in the base case would be reduced or substantially altered by as much as 50 percent in one or more southern Kenai Peninsula communities for at least 1 year and to a lesser extent for selected subsistence resources 2 to 3 years beyond; effects are caused by one or more large (≥1,000 bbl) accidental oil spills that have a 27-percent chance of occurring.

k. Effects on Sociocultural Systems: Section III.C.4 describes the sociocultural systems for those communities in Southcentral Alaska that could be affected by the proposed lease sale and describes effects from the EVOS. This section is divided into three phases: the prelease phase, the exploration phase, and the development and production phase. Except for the prelease phase, the analysis that follows takes into account effects from routine activities that may result from the sale, such as the introduction of industrial activities and changes in community population levels; potential effects on subsistence-harvest patterns; and effects from accidental oil spills and cleanup efforts.

(1) Prelease Phase: The process of initiating, preparing for, and interacting with the public on a proposed lease sale is a distinct impact-producing agent within the human environment. Prelease impacts on sociocultural systems would be expected among individuals, organizations, and communities potentially impacted by the proposed lease sale, starting with the announcement of the sale as part of the 5-year lease-sale program and the initiation of applicable socioeconomic or biological studies. From that point forward, with the preparation of an EIS and issuance of a notice of sale, there are innumerable announcements and meetings held on the topic of the proposed sale as a means of informing the public and gaining feedback on specific issues. The is the phase Freudenburg and Gramling (1994) refer to as containing threats and opportunities within the human environment, with the choice among these polar attributes and variations thereon depending on the values and experiences of the beholder. Individuals in lower Cook Inlet communities are particularly sensitive to environmental contamination issues because of the *Exxon Valdez* oil spill, which they experienced first hand.

Examples of sociocultural impacts from the pre-lease process include:

- Fear of being inundated with outsiders with different values and sense of place that will change existing institutions and disrupt cultural continuity.
- Fear of oil spills and this threat to the future of the natural world.
- Memories of EVOS and previous OCS litigation.
- Fear that subsistence foods will be contaminated or the environment destroyed.
- The need to expend individual and social energy to mobilize for advocacy and activism with local and Federal agencies.
- The need to expend personal and professional time to interact with local and Federal agencies.
- The need to retrace the steps taken in previous years to oppose offshore drilling again, and wondering if it is all worth the frustration and pain.
- The need to respond to questions posed by researchers and agency outreach workers.

- The need to work with lawyers to draft litigation to attempt to stop the proposed sale.

The length of time over which the EIS process was spread added to the buildup of stress and anxiety over the sale but allowed MMS time to mediate some differences, such as in the deletion of Shelikof Strait.

(2) Exploration Phase: The exploration phase of the base case spans a 2-year period (1997-1998), during which time eight wells would be drilled from a single drilling platform. Support and logistic activities for the exploration phase are assumed to take place from existing air and marine facilities on the Kenai Peninsula. No additional support bases or industrial enclaves are assumed to be constructed.

Industrial activities associated with the exploration phase would not represent the introduction of new industrial activities on the Kenai Peninsula. Rather, such activities would represent a continuation of existing oil-industry-associated operations that are currently based on the Kenai Peninsula. As shown in Table IV.B.1.k-1, sale-related resident population associated with the exploration phase should represent about 2 percent of the KPB resident population. The characteristics of the population associated with exploration activities should be compatible with the general character of the existing population on the Kenai Peninsula that is associated with the oil industry.

Effects on sociocultural systems from effects on subsistence harvests during the exploration phase should be minimal, because effects on subsistence harvests are not expected to create measurable changes in the availability or accessibility of subsistence resources. Little or no effect also would be registered on sociocultural systems from small offshore oil spills experienced in the exploration phase, because they are easily cleaned up or dispersed. (Discharges from offshore platforms are regulated by the USEPA.) The operation of an exploration platform in lower Cook Inlet waters would represent a threat to some residents, although offshore platforms have become an accepted part of the offshore landscape in northern Cook Inlet for decades.

(3) Development and Production Phase: The development and production phase of the base case extends for 22 years (1999-2021), during which time three production platforms would be installed, 125 mi of pipeline would be laid, 48 production and service wells would be drilled, and 19 years of oil production would take place to produce an assumed total of 200 MMbbl of oil. Before activities such as this can take place, however, a planning process ensues which largely involves the preparation of a developmental EIS.

(a) Changes Resulting from Postlease-Planning Processes: Discovery during the exploration phase of oil in quantities large enough for commercial production produces the need to prepare a developmental EIS. The attributes considered at that time are not the hypothetical scenarios developed here for purposes of analysis but concrete information, plans, and programs for extracting the oil for market. The announcement of a commercial discovery and field potential as well as the initiation of the process to prepare a developmental EIS again have the potential for re-visiting the psychological, sociocultural, and sociopolitical stress and disruptions as in the prelease phase, although the stakes at that time should be different. The question then would be more as to how development would take place than whether the leasing action should take place at all. Because of this, there is a greater opportunity to mitigate expected impacts through stipulation, mediation, or negotiation than during the prelease process.

(b) Changes in Industrial Activities and Population Levels: The majority of resident population generated by the base case is assumed to reside within the KPB. Table IV.B.1.k-1 shows a forecast of resident population for the KPB with and without the sale and an estimate of the portion of such population that could reside in the communities of Kenai and Homer, if the ratios of 1990 population within the KPB were to pertain. The forecast of KPB resident population with and without the sale is derived from use of the RAM model, an explanation of which is contained in Appendix G. The estimates for Kenai and Homer were derived from the proportions displayed in the 1990 U.S. decennial census of population, with Kenai city accounting for 15.5 percent and Homer city accounting for 9.0 percent of total KPB population.

As shown in Table IV.B.1.k-1, the lease sale is estimated to increase the resident population in the KPB initially from around 800 to 900 residents to a more long-term, average figure of around 2,300 residents, with a peak in 2001 of about 4,000 residents. When these estimates are applied to the KPB as a whole, sale-related activities would account initially for about 2 percent and reach a peak of about 8 to 9 percent of total resident population in 2001, with a long-term prospect of contributing about 4 to 5 percent of total KPB resident population. As might be

Table IV.B.1.k-1
Alternative Distribution of Sale-Related Resident Population within the Kenai Peninsula Borough (KPB): Cities of Kenai and Homer; Base Case

Year	KPB Total Resident Population without Sale	KPB Total Resident Population with Sale	Sale-Related Resident Population	KPB Percent of Increase	Kenai Sale-Related Resident Population	Homer Sale-Related Resident Population
1997	39,696	40,613	917	2.3	142	83
1998	40,053	40,943	890	2.2	138	80
1999	40,413	42,319	1,906	4.5	295	172
2000	40,777	43,946	3,169	7.2	491	285
2001	41,144	45,162	4,018	8.9	623	362
2002	41,514	45,140	3,626	8.0	562	326
2003	41,888	44,220	2,332	5.3	361	210
2004	42,265	44,555	2,290	5.1	355	206
2005	42,645	44,936	2,291	5.1	355	206
2006	43,029	45,320	2,291	5.1	355	206
2007	43,416	45,707	2,291	5.0	355	206
2008	43,807	46,098	2,291	5.0	355	206
2009	44,201	46,492	2,291	4.9	355	206
2010	44,599	46,928	2,329	5.0	361	210
2011	45,001	47,330	2,329	4.9	361	210
2012	45,406	47,735	2,329	4.9	361	210
2013	45,814	48,119	2,305	4.8	357	207
2014	46,227	48,517	2,290	4.7	355	206
2015	46,643	48,933	2,290	4.7	355	206
2016	47,062	49,353	2,291	4.6	355	206
2017	47,486	49,776	2,290	4.6	355	206
2018	47,913	50,204	2,291	4.6	355	206
2019	48,345	50,635	2,290	4.5	355	206
2020	48,780	51,070	2,290	4.5	355	206

Source: MMS, Alaska OCS Region.

expected, these proportions generally also would hold true for Kenai and Homer, if we assume that the sale-related population increases would be distributed uniformly within the KPB the same as was found in the 1990 U.S. census of population. This assumption is questionable, however, due to the location of the oil- and gas-industry facilities on the Kenai Peninsula. The more likely prospect is for the preponderance of sale-related resident population to reside in the central peninsula area of the KPB (Table III.C.4-1 identifies the communities and Census Designated Places covered in this area), where the service and support facilities for the Cook Inlet oil and gas industry are located. Because the central peninsula area of the KPB contained about half the KPB population in 1990, Table IV.B.1.k-2 shows the result of halving the forecast for resident population without the sale and then adding all resident population resulting from the sale to these figures.

Even with this approach, however, the added increase of around 9 to 10 percent of total resident population (with a 3-year peak of around 14-16%) is not a significant amount in terms of fostering changes in values or institutions within the central Kenai Peninsula area. The characteristics of the new segment of resident population should be compatible with the character of the central-peninsula resident community and should do little to change sociocultural patterns existing there, because the character of activity and the social and cultural orientations of the persons expected to be involved should be compatible with the recent historical experience of the community.

(c) **Changes in Subsistence-Harvest Patterns**: As discussed in Sec. IV.B.1.j, effects on subsistence-harvest patterns in the base case would be most prominent among southern Kenai Peninsula communities and the communities of Nanwalek and Port Graham. There is an estimated 27-percent chance that one or more oil spills ≥1,000 bbl would occur and an estimated 26-percent chance that such a spill would occur and contact land within 30 days. As a result, these communities would experience subsistence-resource losses, primarily because of the high level of exposure to spills from transportation sources. Such losses would include the lack of resource availability, accessibility, or desirability for use. Reductions in subsistence-harvest levels for specific resources could extend for more than a year.

The social consequences of such effects among southern Kenai Peninsula communities and the communities of Nanwalek and Port Graham could be serious. This is especially so in the Alutiiq communities of Nanwalek and Port Graham, where subsistence is a core cultural institution with complex social meaning. Threats to the subsistence resources and activities that are so fundamentally embedded within Native culture threaten that very culture itself and the meaning it gives to daily life (Impact Assessment, Inc., 1990). In addition to anxiety over the loss of subsistence resources and the quality of the habitats that nurture them, the *Exxon Valdez* experience showed heightened and continuing concern over the health effects of eating contaminated wild foods and the need to depend on the knowledge of others about environmental contamination (see Meganak, 1990; Fall, 1992; McMullen, 1993). This loss of control for individuals and communities would be increasingly stressful over the period of time needed to modify subsistence-harvest patterns by selectively changing harvest areas, if available. Even then, searches for uncontaminated resources, such as clams and mussels, would require greater amounts of time because of the distances involved. A large-scale or localized kill of species by environmental contamination forces people to follow the wasteful practice of harvesting smaller and undersized subsistence resources to achieve previous harvest levels (see McMullen, 1993).

Associated culturally significant activities would be modified and could decline, such as the organization of subsistence activities among kinship and friendship groups and the relationships among those that customarily process and share subsistence harvests. There could be reductions in the amount of subsistence food shared with other households, received from other families, and available for sharing with elders, who are especially affected by the disruption of subsistence activities. Substantial changes in these and other aspects of subsistence activities take away the means by which people derive order and meaning from their lives and introduce uncertainty and confusion.

Elsewhere in Cook Inlet and on Kodiak Island and the Alaska Peninsula, effects on subsistence-harvest patterns are estimated to be limited in magnitude and duration and not of such a nature to cause measurable changes in the availability, accessibility, or desirability of most subsistence resources.

(d) **Changes Resulting from Accidental Spills and Postspill-Cleanup Events:** Accidental oil spills affect the state of individual and community well-being, which persists through postspill-cleanup events and beyond—effects that are not uniformly distributed throughout the population (see Picou and Gill, 1993; Kernes, 1992). Individuals and communities that depend on income from commercial fisheries would

Table IV.B.1.k-2
Alternative Distribution of Sale-Related Resident Population within the Kenai Peninsula Borough (KPB): Mid-Peninsula Area; Base Case

Year	Mid-Peninsula Total Resident Population without Sale	Sale-Related Resident Population	Mid-Peninsula Resident Population with Sale	Mid-Peninsula Percentage of Increase
1997	19,848	917	20,765	4.4
1998	20,027	890	20,917	4.3
1999	20,207	1,906	22,113	8.6
2000	20,389	3,169	23,558	13.5
2001	20,572	4,018	24,590	16.3
2002	20,757	3,626	24,383	14.9
2003	20,944	2,332	23,276	10.0
2004	21,133	2,290	23,423	9.8
2005	21,323	2,291	23,614	9.7
2006	21,515	2,291	23,806	9.6
2007	21,708	2,291	23,999	9.5
2008	21,904	2,291	24,195	9.5
2009	22,101	2,291	24,392	9.4
2010	22,300	2,329	24,629	9.5
2011	22,501	2,329	24,830	9.4
2012	22,703	2,329	25,032	9.3
2013	22,907	2,305	25,212	9.1
2014	23,114	2,290	25,404	9.0
2015	23,322	2,290	25,612	8.9
2016	23,531	2,291	25,822	8.9
2017	23,743	2,290	26,033	8.8
2018	23,957	2,291	26,248	8.7
2019	24,173	2,290	26,463	8.7
2020	24,390	2,290	26,680	8.6

Source: MMS, Alaska OCS Region.

experience stress and anxiety from debt burden, income shortfalls, litigation, and fear for the future should the fisheries they participate in or depend on in other capacities be shortened or terminated due to an accidental spill.

The size and geography of spills used in the base case are much smaller and more localized than the *Exxon Valdez* spill, which was pervasive geographically and temporally. Because of this, the magnitude of institutional and social effects among southern Kenai Peninsula communities should not be comparable to the effects from the *Exxon Valdez* postspill experience (described in Sec. III.C.4), although the nature of the effects may be comparable. The duration of sociocultural effects experienced would depend on the severity of the initial experience (Picou and Gill, 1993).

Summary: Effects on sociocultural systems begin with the prelease processes of announcing the proposed sale and carrying out the preparation of an EIS. Given a significant oil discovery, planning processes are again engaged to prepare a developmental EIS. Each of these sometimes lengthy processes cause stress and anxiety among affected publics, although the stakes would be different. Based on the scenario data used here for the purposes of analysis, base-case effects are centered on the Kenai Peninsula, including the Alutiiq communities of Nanwalek and Port Graham. Resident population associated with the sale would do little to change existing sociocultural systems in the central Kenai Peninsula area, where new resident population would be expected to live. There is an estimated 27-percent chance that one or more oil spills ≥1,000 bbl would occur and an estimated 26-percent chance that such an oil spill would occur and contact land within 30 days; the individual, social, and institutional effects would be serious. Individual and social stress and anxiety levels would be expected to increase in southern Kenai Peninsula communities over the loss of subsistence resources, contamination of habitat, fear of the health effects of eating contaminated wild foods, and the need to depend on the knowledge of others about environmental contamination. In the Alutiiq communities, the organization of subsistence activities among kinship and friendship groups and the relationships among those that customarily process and share subsistence harvests also would be modified and could decline in importance. Stress-induced increases in alcohol and drug abuse would produce increases in numerous substance-abuse problems, such as child abuse, domestic violence, and accidents. The duration of individual and social effects would depend on the severity of the oil-spill experience. Institutionally, communities would undergo considerable disruption and community conflict, with litigation constituting a secondary source of postspill social and community stress.

Conclusion: In the base case, sociocultural systems in one or more southern Kenai Peninsula communities would undergo periodic episodes of increased individual, social, and institutional stress and disruption that would last for several years in each instance and endure in memory for decades; effects are caused by both prelease and potential postlease processes and events.

I. Effects on Archaeological and Cultural Resources: There are 79 known shipwrecks within the proposed sale area (see Table III.C.5-2). Eleven shipwrecks affected by the base case—*S. No. 2*, *Flying Scud*, *Elizabeth Mary*, *Alton*, *Anita*, *Ouline*, *Tinea*, *Cougar*, *Solar*, *Katovia*, and *Craig Foss*—lie on the Federal OCS (see Table III.C.5-3 for the list and lease blocks). The other shipwrecks lie in State waters. The OCS lease blocks that have the potential for prehistoric archaeological resources are listed in Appendix F. There also are over 1,000 known archaeological sites onshore that could be affected by activities associated with the proposed lease sale.

The most important understanding obtained from past large oil-spill cleanups is that archaeological resources generally were not directly affected by the spills (Bittner, 1993). The largest effects came from vandalism, because more people knew about the location of the resources and were present at the sites. That knowledge increases as the population and activities increase during the cleanup process.

A second type of effect, that resulting directly from cleanup work, was identified. The effects of cleanup were slight during the large spill—the *Exxon Valdez*—because the work plan for cleanup constantly was reviewed, and cleanup techniques were changed as needed to protect archeological and cultural resources (Bittner, 1993). The effects from oil spills and cleanup operations on archaeological and cultural sites (the resources are described in Sec. III.C.5) in the Cook Inlet sale area would be similar in types of effects but varying in degree depending on the level of exploration. If oil is found, the effect will depend on the level of development. However, for the purpose of this analysis, the maximum level of activity is assumed. Assumptions about where oil-spill cleanup occurs are made in the first part of the following analyses. Each of the sets of land segments estimated to be contacted by oil based on the OSRA (e.g., western Kodiak Island, Kenai Peninsula, Kachemak Bay, Katmai, McNeil River State

Park, and Lake Clark National Park) are assumed to be contacted and affected by the cleanup process and personnel.

Exploration and development activities may disturb both offshore and onshore resources. Known and previously unknown archaeological sites may be lost through looting, or indiscriminate or accidental activity onshore and in the intertidal zone.

In the following paragraphs, geographical areas having archaeological significance will be described (1) for risk of effects and (2) for estimated effects on archaeological resources.

(1) <u>Risk of the Base Case on Western Kodiak Island to Southern Kenai Peninsula:</u> Marine support for exploratory drilling in the Cook Inlet likely will be staged from the Nikiski Industrial Complex on the western shore of the Kenai Peninsula. This facility has an existing heliport for resupply trips. Air support for offshore drilling in the Cook Inlet during the exploratory period is expected to come from Nikiski. Effects on underwater archaeological resources could result from disturbance to shipwrecks, prehistoric and historic sites by the addition of approximately 125 mi of pipelines to Nikiski. Onshore prehistoric and historic sites may be affected by accidental disturbance due to increases in industrial populations. Effects-causing factors are similar to those given for the EVOS (Bittner, 1993). The onshore archaeological resources in the planning area may be indirectly adversely affected by vandalism and the activity of cleanup crews, if a spill ≥1,000 bbl were to contact the shoreline.

Effects on submerged archaeological resources would result from direct disturbance of a historic shipwreck or submerged prehistoric site by a drilling rig or platform. Effects also may result from pipeline and onshore facility construction.

Onshore prehistoric and historic sites may be affected by accidental disturbance due to the placement of onshore marine-support facilities and to increases in industrial populations. Under the National Historic Preservation Act, onshore facilities requiring any Federal permits or funding for construction would require archaeological resource evaluations prior to construction and any surface disturbance. Similarly, the Alaska Historic Preservation Act of 1974, Section 41.35.070, provides for archaeological evaluations prior to public construction projects. Because of these in-place mitigating measures, it is unlikely that placement of onshore marine-support facilities would result in the disturbance of significant archaeological resources.

Population increases projected under the base case (see Sec. IV.B.1.h, Economy) may result in increased accidental or intentional disturbance of archaeological resources. Onshore archaeological resources also may be indirectly adversely affected by cleanup operations and vandalism, if an oil spill occurs. These effects would be similar to those described by Bittner (1993) resulting from cleanup of the EVOS. The effects on archaeological resources from increased populations and oil spills are unpredictable and cannot be easily prevented or mitigated.

(a) <u>Western Kodiak Island:</u> Assuming an oil spill ≥1,000 bbl occurs at any pipeline segment P1 through P5 and T1 and T2 or tanker segment T1 through T8 (Fig. IV.A.2-5), the chance estimated chance of contact within 30 days to western Kodiak Island LS's 67 through 75 is assumed to be the chance of contact to archaeological and shipwreck resources in these areas. This conditional probability (expressed as percent chance) is between <0.5 and 9 percent during the summer and between <0.5 and 7 percent during the winter (Appendix B, Tables B-10 and B-13). The combined probability (expressed as percent chance) of one or more oil spills ≥1,000 bbl occurring and contacting these land segments is <0.5 percent (Appendix B, Table B-14).

Because important prehistoric and historic archaeological and shipwreck resources are in the area of these land segments and because the above conditional and combined probabilities show some chance of contact and occurrence and contact, the western Kodiak Island land segments discussed above have been chosen for effects analyses.

(b) <u>Kenai Peninsula:</u> Assuming an oil spill ≥1,000 bbl occurs at tanker or pipeline segments (T1-T8, P1-P5), the estimated chance of contact to Kenai Peninsula LS's 38 through 43, which may contain archaeological and shipwreck resources, within 30 days is between <0.5 and 13 percent during the summer and <0.5 and 8 percent during the winter (Appendix B, Tables B-10 and B-13). The combined probability of one or more spills ≥ 1,000 bbl occurring and contacting these land segments is ≤ 1 percent (Appendix B, Table B-14).

Because important prehistoric and historic archaeological and shipwreck resources are in the area of these land segments and because the above conditional and combined probabilities show some chance of contact and occurrence and contact, the Kenai Peninsula land segments discussed above were chosen for effects analyses.

(c) **Kachemak Bay:** If an oil spill ≥ 1,000 bbl occurs at tanker or pipeline segments (T1-T8, P1-P5), the 30-day estimated chance of contact to Kachemak Bay LS's 44 through 49, which may contain archaeological and shipwreck resources, is between <0.5 and 11 percent during the summer and between <0.5 and 16 percent during the winter (Appendix B, Tables B-10 and B-13). The combined probability (expressed as percent chance) of one or more spills ≥ 1,000 bbl occurring and contacting these land segments is <0.5 percent (Appendix B, Table B-14).

Because important prehistoric and historic archaeological and shipwreck resources are in the area of these land segments and because the above conditional and combined probabilities show some chance of contact and occurrence and contact, the Kachemak Bay land segments discussed above were chosen for effects analyses.

(2) **Risk of the Base Case on the Alaska Peninsula:** Most industrial activity will occur in the Cook Inlet for the Alternative I base case, reducing the possibility that a number of archaeological resources would be disturbed along the Alaska Peninsula. However, a spill is assumed to occur that could contact the east side of the Alaska Peninsula.

(a) **Katmai Area:** Assuming an oil spill ≥ 1,000 bbl occurs at any tanker or pipeline segment (T1-T8, P1-P5) (Fig. IV.A.2-5), the estimated chance of contact to LS's 15 through 23 is assumed to be the chance of contact to archaeological and shipwreck resources in these areas within 30 days. The chance of contact to LS's 15 through 23 is between <0.5 and 19 percent during the summer and between <0.5 and 21 percent during winter (Appendix B, Tables B-10 and B-13). The combined probability (expressed as percent chance) of one or more spills ≥ 1,000 bbl occurring and contacting LS's 15 through 23 is between <0.5 and 2 percent (Appendix B, Table B-14).

Because important prehistoric and historic archaeological and shipwreck resources are in the area of these land segments and because the above conditional and combined probabilities show reason for concern, the Katmai land segments discussed above were chosen for effects analyses.

(b) **McNeil River State Park:** If an oil spill ≥ 1,000 bbl occurs at tanker or pipeline segments (T1-T8, P1-P5) (Fig. IV.A.2-5), the estimated chance of contact to LS's 24 through 30 (archaeological and shipwreck resources at McNeil State Park and the Mt. Augustine volcano) within 30 days is between <0.5 and 20 percent during the summer and between <0.5 and 21 percent during winter (Appendix B, Tables B-10 and B-13). The combined probability (expressed as percent chance) of one or more spills ≥ 1,000 bbl occurring and contacting these land segments is ≤2 percent (Appendix B, Table B-14).

Many archaeological resources at the shores of the McNeil River State Game Sanctuary and Mt. Augustine volcano area, referred to generally in Section III.C.5, have some chance of contact and occurrence and contact risks.

Because important prehistoric and historic archaeological and shipwreck resources are in the area of these land segments and because the above conditional and combined probabilities show some chance of contact and occurrence and contact, the McNeil River State Park land segments discussed above were chosen for effects analyses.

(c) **Lake Clark National Park:** Should an oil spill ≥ 1,000 bbl occur at any tanker or pipeline segment (T1-T8, P1-P5) (Fig. IV.A.2-5), the estimated chance of contact at the Lake Clark National Park and Preserve area, LS's 30 through 36, is assumed to be the chance of contact to archaeological and shipwreck resources in these areas within 30 days. The chance of contact to LS's 30 through 36 is between <0.5 and 26 percent during the summer and <0.5 and 28 percent during winter (Appendix B, Tables B-10 and B-13). The combined probability (expressed as percent chance) of one or more spills ≥ 1,000 bbl occurring and contacting these land segments is ≤2 percent (Appendix B, Table B-14).

Archaeological resources, referred to rally in Figure III.C.5-1, exist at the shores near the Lake Clark National Park and Preserve area. Land segments 31 through 36 representing this area have some spill-contact and occurrence and contact risks.

Because important prehistoric and historic archaeological and shipwreck resources are in the area of these land segments and because the above conditional and combined probabilities show reason for concern, the Lake Clark State Park National Park land segments discussed above were chosen for effects analyses.

(3) Effects of the Base Case on Archaeological Resources: An archaeological analysis of geophysical survey data is required prior to permitting lease activities on those lease blocks identified as having the potential for historic shipwreck occurrence. Because these surveys are very effective in locating evidence of shipwrecks and areas having the potential for submerged prehistoric sites, potential sites should be detected and avoided by lease activities. Therefore, the expected effect to submerged archaeological resources is very low.

The National Historic Preservation Act requires that prior to issuing any Federal licenses, permits, or funding for a project, the potential effects on significant archaeological resources be evaluated. The Alaska Historic Preservation Act of 1974 provides for archaeological evaluations prior to public construction projects, and the State Historic Preservation Office (SHPO) is given the opportunity to review and comment on most projects. Because of these in-place mitigating measures, it is unlikely that placement of onshore marine-support facilities would result in the disturbance of significant archaeological resources. Only the direct effects from oil spills and the indirect effects of oil-spill-cleanup operations and the potential for increased vandalism of archaeological sites by oil-spill-cleanup crews and support populations cannot be effectively mitigated.

National Register sites that may be affected by the base-case oil spill and cleanup activities (see Sec. III.C.5) exist within the segments selected and discussed above, that is, the western Kodiak Island area, the southern Kenai Peninsula, and the Alaska Peninsula. The effects from oil spills on environmental resources in the Cook Inlet sale area would be similar to those from the EVOS, but varying in degree of effect. Two studies of intertidal disturbance, the EVOS Cultural Resource Program and a paper on archaeological protection presented at the Atlanta meeting of the ASTM, are in close agreement as to the effects of the spill on shore and intertidal resources. In the first study by Mobley et al. (1990), there were 1,000 archaeological sites in the area affected by the EVOS (AHRF, 1993), and about 24 of these, or <3 percent, were damaged (Mobley et al., 1990). In the second study (Wooley and Haggarty, 1993), a total of 609 sites were identified:

> Of . . . 174 sites near oiled shorelines that had intertidal components, 126 were near lightly or very lightly oiled shorelines where the level of cleanup was generally low compared with moderately or heavily oiled shorelines. Forty-eight intertidal sites were located near moderately and heavily oiled shorelines, and 34 of these had upland components. [i.e, were more than 200 m from shoreline] that were not exposed to direct oiling. Intertidal sites were inspected and monitored by CRP [cultural resources program] staff consistent with the degree of oiling and the intensity of cleanup conducted.

The sites affected by the major causes, that is, the remaining 14 sites, are 2 to 3 percent of the 609 sites. There is, therefore, an agreement on the level of effects between the Mobley et al. (1990) and the Wooley and Haggarty (1993) studies that effects would occur to <3 percent of the sites in an area affected by spilled oil.

The estimated effects of factors similar to the EVOS (i.e., oiling, vandalism, disturbance due to cleaning of the area, and site visitor wear and tear, etc.) would be proportionate to the degree of activity of the Sale 149 base case (see Sec. II.A.3 for details). Based on previous studies, the percentage of sites affected by all the effect factors similar to EVOS applied to the Sale 149 base case would, therefore, be less than from the EVOS, or <3 percent.

Prehistoric people arrived in Cook Inlet before they arrived in Prince William Sound (Mobley et al., 1990) and it is assumed that there are at least an estimated same number of sites (1,000) in Cook Inlet land segments selected for this analysis.

As explained above, the effects of base-case cleanup activities, vandalism, and wear and tear on archaeological sites over the duration of the lease are expected to be less than the EVOS case-study effects on archaeological resources

(<3%). Although the <3-percent estimated disturbed sites is based on the actual experience of the EVOS, the effect on sites from the base-case would depend on the significance of the sites disturbed. Significance is determined when a site is considered for the National Register and depends on many archaeological factors. Details can be obtained by consultation with the SHPO.

There are some archaeological resources onshore of the Alaska Peninsula, particularly at the heads of bays. The offshore area has few existing landforms indicating areas of prehistoric site potential that could have survived the currents and wave action. Shipwrecks of the peninsula shore may be disturbed by increased interest in the area; and the few shipwrecks thought to be in the area might be located as a result of exploration and, if oil is found, development activities. Existing laws and regulations protecting both onshore and offshore resources would prevent disturbance in most cases. The MMS procedures would require consultation with the SHPO prior to any exploration or development activities in areas of known sites.

Summary: Effects on submerged archaeological resources may result from disturbance to shipwrecks, prehistoric sites, and historic sites (Sec. III.C.5) by activities such as laying pipelines, dragging anchors of operating and supply vessels, and anchoring drill rigs. Onshore prehistoric and historic sites may be affected by construction of pipelines, onshore-support facilities, increases in industrial personnel and supporting populations, and through accidental disturbance. The routine disturbances would be mitigated.

Oil spills (from supply vessels) for drilling operations are not expected to be large. These require only small cleanup operations and would not involve bulldozers, trucks, and other heavy equipment to be moved to the oil-spill-cleanup area. Only the direct effects from oil spills and the indirect effects of oil-spill-cleanup operations and the potential for increased vandalism of archaeological sites by oil-spill-cleanup crews and support populations cannot be effectively mitigated.

Effects on archaeological resources (prehistoric archaeological sites, historic sites, and shipwrecks within Alaska's 3-mi zone) are due to activities of exploration and development personnel and other indirect increases in population brought on by exploration, development, and oil-cleanup activities. Effects on Kenai, Kachemak Bay, Kodiak and the Alaska Peninsula onshore archaeological resources and offshore resources are expected to be such that <3 percent are affected. The effects of cleanup activities, vandalism, and wear and tear on archaeological sites over the duration of the lease also are not expected to exceed effects found in the EVOS case study on archaeological resources.

Conclusion: The effects of the base case on submerged archaeological resources, historical resources, and submerged offshore shipwrecks are expected to be effectively mitigated. It is expected that the effects of cleanup activities, vandalism, and wear and tear on archaeological sites and shipwrecks on the shore and within the State's 3-mi zone over the duration of the lease would affect <3 percent (an estimated <30 sites) of those resources.

m. Effects on National and State Parks and Related Recreational Places: In the national and State parks and related recreational places, resources are abundant and of high quality (Sec. III.C.6).

It is assumed that 200 MMbbl of oil will be found. Drilling rigs and platforms can directly affect public perceptions of coastal and nearshore seascape views. See Section III.C, where resources are given for each of the following areas of risk analysis and effects analysis. Indirectly, rigs, platforms, and transportation vessels are associated with oil spills and marine trash and debris, which also can adversely affect the aesthetics of the marine environment or coastal shorefront. Platforms and drilling rigs (in this proposal, only one drill platform will be used) established in the nearshore Federal oil and gas lease tracts (3-10 mi from shore) can be readily seen and recognized during good weather conditions from both the eastern and western sides of Cook Inlet and by passengers in planes flying over the platforms. Set against the background of mountains and volcanoes, some rigs or their replacements have been in view for over 15 years since drilling started in the area. The one new offshore rig and platform 12 or more miles out from shore may be barely perceptible from shore in the fairest of weather conditions, and it would be indistinguishable from objects such as ships or tankers and thus unlikely to spoil natural shorefront vistas. A platform, however, would be part of the viewing environment from passenger planes flying near them. For example, there are approximately 30 air flights per day between Anchorage and cities of the Kenai peninsula and Kodiak on common carriers. Private aircraft make numerous special flights. Some tourism operatives have what they call "flightseeing" trips over glaciers and volcanoes in the area. New platforms, rigs, or flares would have some effect on the view because they change the viewscape.

Most other effects on the resources of national and State parks and related recreational places would be from changes in numbers of users. A population increase is expected, which will be generated by OCS employment from proposed exploration and development activities (Sec. IV.B.1.h, Economy). Direct OCS employment would peak at about 1,463 jobs in 2000, and drop to 849 in 2003. Employment would stay at that level to 2020. This increase in users of recreational resources would produce relatively modest stress to visual aesthetics during the life of the lease, because such change is incremental as compared to macrochanges, such as the addition of an oil rig to the viewscape.

(1) **Oil Spill Risk Analysis by Land Segment:** In the following paragraphs, the risk of oil from an oil spill reaching the coastline of significant national and State parks and related recreational places is discussed. Assumptions about where the oil-spill cleanup occurs are made in the first part of each of the following analyses. Each of the segment locations (e.g., western Kodiak Island, Kenai Peninsula, Kachemak Bay, Katmai National Park, McNeil River State Park, and Lake Clark National Park) are assumed to be contacted and affected by the cleanup process and personnel.

These land segments are inhabited by brown bears, moose, caribou, and other grazing animals; salmon, trout, and other fishes; and birds of many kinds, and are used by many for hunting, recreation, sportfishing, hiking, sightseeing, and other recreational and subsistence purposes. The shores of these land segments have physical characteristics such as cliffs, waterfalls, and beaches that bring admiring tourists from all over the world. Details on the uses of these areas are found in Section III.C.6, and information on the specific resources and physical characteristics of the environment is found in Section III.

(a) **Western Kodiak Island:** Assuming an oil spill ≥1,000 bbl occurs at any pipeline segment P1 through P5 and T1 and T2 or tanker segment T1 through T8 (Fig. IV.A.2-5), the estimated chance of contact to western Kodiak Island LS's 67 through 75 is assumed to be the chance of contact to national parks, wildlife refuges, and recreational area resources on western Kodiak Island within 30 days. This conditional probability (expressed as percent chance) is between <0.5 and 9 percent during the summer and between <0.5 and 7 percent during the winter (Appendix B, Tables B-10 and B-13). The combined probability (expressed as percent chance) of one or more oil spills ≥1,000 bbl occurring and contacting these land segments is between <0.5 and 1 percent (Appendix B, Table B-14).

(b) **Kenai Peninsula:** Assuming an oil spill ≥1,000 bbl occurs at transportation or pipeline segments (T1-T8, P1-P5), the estimated chance of contact to Kenai Peninsula (LS's 38 through 43), Captain Cook State Park, within 30 days is between <0.5 and 13 percent during the summer and <0.5 and 8 percent during the winter (Appendix B, Tables B-10 and B-13). The combined probability of one or more spills ≥1,000 bbl occurring and contacting these land segments ranges from <0.5 to 1 percent (Appendix B, Table B-14).

(c) **Kachemak Bay:** If an oil spill ≥1,000 bbl occurs at transportation segment T1 through T8 or pipeline segments P1 through P5 (Fig. IV.A.2-5), the 30-day estimated chance of contact to Kachemak Bay LS's 44 through 49, which may contain national parks, wildlife refuges, and recreational area resources at Kachemak Bay near Kachemak Bay State Park, is between <0.5 and 11 percent during the summer and between <0.5 and 16 percent during the winter (Appendix B, Tables B-10 and B-13). The combined probability (expressed as percent chance) of one or more spills ≥1,000 bbl occurring and contacting these land segments is <0.5 to 1 percent (Appendix B, Table B-14).

(d) **Katmai Area:** Assuming an oil spill ≥1,000 bbl occurs at any transportation or pipeline segment (P1-P5, T1-T8) (Fig. IV.A.2-5), the estimated chance of contact to LS's 15 through 23 is assumed to be the chance of contact to national parks, wildlife refuges, and recreational area resources at the Katmai National Park area within 30 days. The chance of contact to LS's 15 through 23 is between <0.5 and 19 percent during the summer and between <0.5 and 21 percent during winter (Appendix B, Tables B-10 and B-13). The combined probability (expressed as percent chance) of one or more spills ≥1,000 bbl occurring and contacting LS's 15 through 23 is ranges from <0.5 and 2 percent (Appendix B, Table B-14).

(e) **McNeil River State Park:** If an oil spill ≥1,000 bbl occurs at transportation or pipeline segments (T1-T8, P1-P5) (Fig. IV.A.2-5), the estimated chance of contact to LS's 24 through 30 (resources at McNeil River State Park and Mt. Augustine volcano area) within 30 days is between <0.5 and 21 percent during the summer and between <0.5 and 20 percent during winter (Appendix B, Tables B-10 and B-13). The combined probability (expressed as percent chance) of one or more spills ≥1,000 bbl occurring and contacting these land segments is ≤2 percent (Appendix B, Table B-14).

(f) Lake Clark National Park: Should an oil spill ≥1,000 bbl occur at any tanker or pipeline segments (T1-T8, P1-P5) (Fig. IV.A.2-5), the estimated chance of contact at the Lake Clark National Park and Preserve area (LS's 30-36,) is between <0.5 and 26 percent during the summer and <0.5 and 28 percent during winter (Appendix B, Tables B-10 and B-13). The combined probability (expressed as percent chance) of one or more spills ≥1,000 bbl occurring and contacting these land segments is ≤2 percent (Appendix B, Table B-14).

(2) Other Effects of the Base Case on National and State Parks and Related Recreational Places: The mitigating measures described in this EIS (Sec. II.H) will be effective in preventing harm to resources of national and State parks and related recreational places but may not be very effective for protection against damage due to oil-spill-cleanup activities.

(a) Effects of the Base Case on Western Kodiak Island and the Southern Kenai Peninsula Resources: The Kodiak Islands group and the adjacent Alaska Peninsula offer opportunities for a variety of recreational activities, including sportfishing, hunting, collecting, sightseeing, and flightseeing (see Sec. III.C.6). Most effects on recreation and tourism would be from changes in numbers of users, property values, and visual qualities as a result of the exploration activities. The increase in users of recreational resources would not place serious stress on the visual qualities and property values in a local area for any long period of time. Visual qualities would be changed in this pristine area by the appearance of one oil platform, if it is within a 12-mi zone of a recreational area. A gas flare at night also would be visible at considerable distances. These changes in visual quality would be local (since no drilling is to occur west of Kodiak Island, no effect is anticipated) and would extend only for short periods of high activity (such as pipelaying, which may occur south and west of the Kenai Peninsula, P4 and P6).

Some recreational areas may be closed for a short time due to spills from supply vessels. Use of park, refuge, and recreation land for base-case-related activities would not be allowed. No increased population in the Kodiak Island area is expected from this lease sale. The bulk of resident new population related to exploration would be concentrated in the Nikiski and Kenai Peninsula areas.

Two studies of intertidal disturbance, the 1989 EVOS Cultural Resource Program and a paper on archaeological protection presented at the Atlanta meeting of the ASTM, are in close agreement as to the effects of the spill on shore and intertidal resources. In the first study by Mobley et al. (1990), 24 resources (2.4%) were disturbed. The second EVOS case studied by Wooley and Haggarty (1993) is relevant to national parks, wildlife refuges, and recreational area resources because it involves the same intertidal areas. Of the 360 sites, that were within 200 m of an oiled shoreline, over half (186) were located entirely in the uplands with no direct exposure to oil. These sites were protected from the indirect effects of cleanup activities by individual site-protection constraints, the level of which generally increased as the degree of shoreline oiling and the need for cleanup increased. The Wooley and Haggarty(1993) study states:

> Of . . 174 sites near oiled shorelines that had intertidal components, 126 were near lightly or very lightly oiled shorelines where the level of cleanup was generally low compared with moderately or heavily oiled shorelines. Forty-eight intertidal sites were located near moderately and heavily oiled shorelines, and 34 of these had upland components that were not exposed to direct oiling. Intertidal sites were inspected and the intensity of cleanup conducted.

The remaining sites totaled 14, or about 2 to 3 percent of the 609 sites. There is, therefore, considerable agreement between the Mobley et al. (1990) and the Wooley and Haggarty (1993) studies. The percentage of sites affected by all the similar effect factors of Sale 149 would be about the same (2-3%) for recreation and tourism resources. Assuming there were 1,000 national parks, wildlife refuges, and recreational area viewing sites and an equal number of visitor-use sites in the area of the EVOS (Alaska Visitors Association, 1993, personal comm.), and an estimated 10 percent of these were altered by the effect factors during the first 3 years but recovered by the end of that time, the estimated effects of similar factors (i.e., oiling, vandalism, disturbance from cleanup activities, and site visitor wear and tear, including drops in visitor rates due to an oil spill, etc.) would be proportionate to the number of viewer and user sites and the degree of activity of Sale 149. In the base case, an estimated <3 percent of Cook Inlet environmental resources were present in the land segments discussed above; therefore, due to the risk and the level of activity in this scenario, an estimated <3 percent of the resources would be altered for the 3-year period and would recover after that time.

(b) Effects of the Base Case on the Alaska Peninsula: The resources in national and State parks and related recreational places of the Alaska Peninsula are outstanding (see Sec. III.C.6). Most effects on these resources would be changes in economic values and noneconomic or aesthetic qualities. Changes in the number of users, property values, and visual qualities are examples. Section IV.B.1.h (Economy) estimates resident OCS employment of 410 jobs in 2001. Resident OCS employment would rise to 249 in 2003 and remain at that level to 2020 due to the proposal. These workers and families would reside on the western side of the Kenai Peninsula and probably would cause marginal effects on the Alaska Peninsula. The increase in numbers of users due to the proposal would place some stress on the resources, particularly on the visual qualities and property values in a local area for a period of time. Changes in visual quality would be local and would extend only for short periods of high activity (such as drilling or pipelaying) distributed over the duration of the lease. The proposal adds one more offshore well beyond 3 mi.

Most of the above effects would not be on the Alaska Peninsula side unless the industrial employees would visit that side. Bears, eagles, shorebirds, and other resources along the shoreline and in the park proper would be slightly disturbed by visitors. The National Park and Refuge policy would control the effects on the parks and resources. There would be a disturbance of <3 percent of the resource for a duration of the life of the lease. Any oil-spill-cleanup activity would disturb <3 percent of the resources in the area 200 m toward land from the waterline as it did in the EVOS. Specific effects on bears, eagles, shorebirds, and other resources in the parks, wildlife refuges, and recreational areas are given in the analyses of those resources of this EIS (see Sec. IV.B.1.a-k). Areas designated wilderness on the coast of Katmai National Park and a portion of the coast at Lake Clark National Park are somewhat more sensitive to impacts because of their wilderness character.

Summary: Any closure of water-oriented recreational facilities would be only for short periods due to cleanup of small oil spills. In particular, trends for visitors to national parks and refuges would show a slight loss during the year after a spill (Fig. III.C.6-2) in spite of industrial support of extensive advertising in other States to bring tourists to Alaska. These rates would continue to fall in the year following for Lake Clark but not for Katmai. A slight decrease in park visitors is expected for large spills but not for small spills. Recreational fishing would drop slightly in areas affected by a spill (a year or 2). A decline in spending by visitors would be in proportion to the decline in the number of visitors. Because the recreation and tourism facilities of the Kenai Peninsula already are crowded during the summer season, the additional population due to OCS activities will add somewhat to the congestion at recreational and tourism areas. Steps are being taken at Federal, State, and local levels to increase recreational opportunities; but the problem will continue to exist, and the proposal does add slightly to the problem. However, over the life of the proposal (30 years), the addition is minimal. At any time of the year, public water-oriented recreational facilities in parks, refuges, and recreational areas could be closed for a short time because of oil-spill-cleanup activities.

In the land segments discussed above due to the risk, which for the combined probability estimates is <2 percent, and due to the level of activity in this scenario), an estimated <3 percent of the resources would be altered for the 3-year period and would recover after that time. Areas designated wilderness on the coast of Katmai National Park and a portion of the coast at Lake Clark National Park are somewhat more sensitive to impacts because of their wilderness character.

Conclusion: The effects of the base case from oil-spill cleanup are expected to be greater than the effects of the oil spill itself (Oil Spill Symposium Note, 1993). Effects are expected to reduce visual qualities of the parks very slightly, reduce visitor rates to those parks minimally, and affect the physical and biological resources (<3% of resources affected) for about 3 years. In particular, trends for visitors to national and State parks and related recreational places would show a slight loss during the year after a spill. The rates would continue to fall in the year following for Lake Clark but not for Katmai. A slight decrease in visitors is expected for large spills but not for small spills. Recreational fishing would drop slightly in areas affected by a spill for a year or two after the spill. A decline in spending by visitors would be in proportion to the decline in the number of visitors.

n. <u>Effects on Air Quality</u>: This discussion analyzes the potential degrading effects on air quality by the activities and developments induced by the Sale 149 Alternative I (base case). Supporting materials and discussions are presented in Sections III.A.2 and III.A.6 (descriptions of Cook Inlet and Alaska air-quality status) and IV.A (Basic Assumptions for Effects Assessment).

Air pollutants discussed include nitrogen oxides (NO_X), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter (PM), and volatile organic compounds (VOC). Ozone (O_3) is not emitted directly by any source but is formed in a series of complex photochemical reactions in the atmosphere involving VOC and NO_X.

Nitrogen oxides consists of both nitric oxide (NO) and nitrogen dioxide (NO_2). The NO_x is formed from the oxygen and nitrogen in the air during combustion processes, and the rate of the formation increases with combustion temperature. Nitric oxide will slowly oxidize in the atmosphere to form NO_2; NO_2 and VOC perform a vital role in the formation of photochemical smog. Nitrogen dioxide breaks down under the influence of sunlight, producing NO and atomic oxygen, which then combine with diatomic oxygen to form O_3 or with VOC to form various gaseous and particulate compounds that result in the physiological irritation and reduced visibility typically associated with photochemical smog.

Carbon monoxide is formed by incomplete combustion. It is mainly a problem in areas where there is a high concentration of vehicle traffic. High concentrations of carbon monoxide present a serious threat to human health, because it greatly reduces the capacity of the blood to carry oxygen.

Sulfur dioxide is formed in the combustion of fuels containing sulfur and, in the atmosphere, SO_2 slowly converts to sulfate particles. Sulfates in the presence of fog or clouds may produce sulfuric-acid mist. Entrainment of sulfur oxides or sulfate particles into storm clouds may be a significant contribution to reduced pH levels in precipitation (acid rain).

Emissions of particulate matter associated with combustion consist of particles in the size range $< 10\mu$ in diameter (PM-10). Emissions of particulate matter associated with combustion consists of particulates, especially those in a certain size range of 1 to 3μ, can cause adverse health effects. Particulates in the atmosphere also tend to reduce visibility.

The type and relative amounts of air pollutants generated by offshore operations vary according to the phase of activity. There are basically three phases: exploration, development, and production. For a more detailed discussion of emission sources associated with each phase, refer to Technical Paper No. 83-2 (USDOI, MMS, Pacific OCS Region, 1983a). Significant emission sources are summarized below.

For the exploration phase, emissions would be produced by (1) diesel-fire-power-generating equipment needed for drilling exploratory and delineation wells; (2) tugboats, supply boats, and crew boats in support of drilling activities; and (3) intermittent operations such as mud degassing and well testing. Pollutants generated would primarily consist of NO_X (these would consist of NO and NO_2—ambient air standards are set only for NO_2), CO, and SO_2.

For the development phase, the primary offshore emission source would be (1) piston-driven engines or turbines used to provide power for drilling, (2) heavy construction equipment used to install platforms and pipelines, and (3) tugboats and support vessels. The principal development-phase emissions would consist of NO_2 with lesser amounts of SO_2, CO, and PM.

For the production phase, the primary source of offshore-emissions would be from power generation for oil pumping and water injection. The emissions would consist primarily of NO_x with smaller amounts of CO and PM. Another source of air pollutants would be evaporative losses (VOC) from oil/water separators, pump and compressor seals, valves, and storage tanks. Venting and flaring could be an intermittent source of VOC and SO_2.

Other sources of pollutants related to OCS operations are accidents such as blowouts and oil spills. Typical emissions from OCS accidents consist of hydrocarbons; only fires associated with blowouts or oil spills produce other pollutants.

(1) Air-Quality Regulation and Standards: Federal and State statutes and regulations define air-quality standards in terms of maximum allowable concentrations of specific pollutants for various averaging periods (see Table III.A.6-1). These maxima are designed to protect human health and welfare. However, one exceedance per year is allowed except for standards based on an annual averaging period. The standards also include Prevention of Significant Deterioration (PSD) provisions for NO_2, SO_2, and PM10 to limit deterioration of existing air quality that is better than that otherwise allowed by the standards (an attainment area). Limited incremental concentrations are specified for each PSD pollutant. There are three classes (I, II, and III) of PSD areas, with Class I allowing the least degradation. Class I also restricts degradation of visibility. That portion of the Tuxedni National Wildlife Refuge designated a National Wilderness Area is the only Class I area adjacent to the proposed sale area (State of Alaska, ADEC, 1992). The remaining areas adjacent to the sale area are Class II. Baseline PSD pollutant concentrations and the portion of the PSD increments already consumed are established for each location by the U.S. Environmental Protection Agency (USEPA) and the State of Alaska prior to issuance of air-quality permits. Air-quality standards do not directly address all other potential effects such as acidification of precipitation and freshwater bodies or effects on nonagronomic plant species.

With the enactment of the Clean Air Act Amendments of 1990, the USEPA has jurisdiction for air quality over blocks leased under this lease sale. The lease operators shall comply with Part C of Title I of the Clean Air Act (Prevention of Significant Deterioration of Air Quality) and with the requirements promulgated by USEPA for OCS sources. Section 328 states that for a source located within 25 mi of the seaward boundary of a State, requirements would be the same as would be applicable if the source were located in the corresponding onshore area.

The State of Alaska shall have jurisdiction over the blocks leased, once the State of Alaska has promulgated, with USEPA concurrence, regulations to implement and enforce the requirements of Section 328 the Clean Air Act.

For the Alternative I base case, peak-year emissions from exploration would be from drilling one to two exploration wells and two to three delineation well from one rig. Peak-year emissions from development would include platform and pipeline installation and the drilling of 20 production wells from 2 rigs. Peak-year production emissions would result from operations (producing 17 MMbbl of oil) and transportation. Table IV.B.1.n-1 lists estimated uncontrolled-pollutant emissions for the peak-exploration, peak-development, and peak- production years. The USEPA-approved Offshore and Coastal Dispersion (OCD) model was used to calculate the effects of pollutant emissions due to the proposal on onshore air quality. Because the Class I PSD areas allow for the least amount of degradation, the modeling scenario (i.e., source location) chosen for this analysis is the one that results in the maximum potential effect to the air quality of the designated national wilderness area of the Tuxedni National Wildlife Refuge, the only Class I area adjacent to the proposed sale area. The maximum potential effect at any location in the Class II area would be the same. In all likelihood, effects to the Tuxedni National Wilderness Area would be lower than those calculated by the model. Under Federal and State of Alaska PSD regulations, a PSD review would be required due to the estimated annual uncontrolled NO_x emissions for the peak-development year would exceed 250 tons per year. The lessee would be required to control pollutant emissions through the application of Best Available Control Technology (BACT) to emissions sources. Table IV.B.1.n-2 shows the model estimated pollutant concentrations and compares them with the PSD increments and the national ambient-air-quality standards. The OCD model air-quality analysis performed for air pollutants emitted for exploration, development, and production under the Alternative I base case showed that maximum NO_2 concentration, averaged over a year, would be 0.19, 0.51, and 0.14 $\mu g/m^3$, respectively, at the shoreline; 7.6, 20.4, and 5.6 percent, respectively, of the available Class I increment for NO_2; and .76, 2.04, and .56 percent, respectively, for Class II. (Other pollutants also were modeled; however, NO_2 had the highest concentrations, which were well within PSD increments and air-quality standards.) The existing air quality would be maintained by a large margin.

(2) Other Effects on Air Quality: Other effects of air pollution from OCS activities and other sources on the environment not specifically addressed by air-quality standards include the possibility of damage to vegetation and acidification of coastal areas. Effects may be short term (hours, days, or weeks), long term (seasons or years), regional (Cook Inlet), or local (nearshore only).

A significant increase in ozone concentrations onshore is not likely to result from exploration, development, or production under the Alternative I base case. Photochemical pollutants such as ozone are not emitted directly but rather form in the air from the interaction of other pollutants in the presence of sunshine and heat. Although sunshine is present a majority of each day during the summer in the sale area, temperatures remain relatively low

Table IV.B.1.n-1 -
Estimated Uncontrolled Emissions for the Cook Inlet Sale 149
Alternative I Base Case
(in tons per year)

	Regulated Pollutants				
	CO	NO_x	PM-10	SO_2	VOC
Base Case[1]					
Peak Exploration Year	42.8	224.8	17.6	18.0	6.8
Peak Development Year	533.4	2069.7	163.2	249.2	129.8
Peak Production Year	84.3	298.2	16.8	14.1	12.9

Source: USDOI, MMS, Alaska OCS Region, 1993; Computed from factors in Form and Substance, Inc., and Jacobs Engineering Group, Inc., 1989.

[1] Assumes peak-year emissions from exploration from drilling four exploration/ delineation wells from one rig. Peak-year emissions from development would include platform and pipeline installation and the drilling of 20 production wells from 2 rigs. Peak-year production emmissions would result from operations (producing 17 MMbbl of oil), and transportion.

Table IVB.1.n-2
Comparison of Modeled Air Pollutant Concentrations with Regulatory Limitations
(measured in micrograms per cubic meter)

Averaging Time	Maximum Modeled Concentration Over Land[2]	PSD Increment[1] Class I/Class II	Air-Quality Standard
Base-Case Exploration NO_2 (annual)[4]	0.19	2.5/25	100[3]
Base-Case Development NO_2 (annual)	0.51	2.5/25	100[3]
Base-Case Production NO_2 (annual)	0.14	2.5/25	100[3]

Source: USDOI, MMS, Alaska OCS Region, 1993.

[1] Increment above ambient concentration allowed in a designated PSD area. Ambient baseline concentration for PSD is not established for this area.

[2] Offshore and Coastal Dispersion Model.

[3] Annual arithmetic mean.

[4] Modeling was done on other pollutants and there results were lower than shown for NO_X.

(Brower et al., 1988). Also, activities under the Alternative I base case are offshore and separated from each other, diminishing the combined effects from sale-related activities and greatly increasing atmospheric dispersion of pollutants before they reach shore.

Olson (1982) reviewed susceptibility of fruticose lichen, an important component of the coastal tundra ecosystem, to sulfurous pollutants. There is evidence that SO_2 concentrations as low as 12.0 $\mu g/m^3$ for short periods of time can depress photosynthesis in several lichen species, with damage occurring at 60 $\mu g/m^3$. Also, the sensitivity of lichen to sulfate is increased in the presence of humidity or moisture, conditions that are common on coastal tundra. However, because of the small size and number of sources of SO_2 emissions, the ambient concentrations at most locations may be assumed to be near the lower limits of detectability. Because of the distance of the proposed activities from shore, attendant atmospheric dispersion, and low existing levels of onshore pollutant concentrations, the effect on vegetation under the Alternative I base case is expected to be minimal.

(3) **Effects of Accidental Emissions:** Accidental emissions result from gas blowouts, evaporation of spilled oil, and burning of spilled oil. The number of OCS blowouts—almost entirely gas and/or water—has averaged 3.3 per 1,000 wells drilled since 1956 (Fleury, 1983). The data show no statistical trend of a decreasing rate of occurrence. The blowout rate actually has averaged somewhat higher since 1974, at 4.3 per 1,000 wells drilled; but the difference between the post-1974 period and the longer 1956 to 1982 record is statistically insignificant.

A gas blowout could release 20 tons/day of gaseous hydrocarbons, of which about 2 tons/day would be nonmethane hydrocarbons classified as VOC. The probability of experiencing one or more blowouts in drilling the 48 wells projected for the Alternative I base case is estimated to be 8 to 11 percent. If a gas blowout occurred, it would be unlikely to persist >1 day; and it would very likely release <2 tons of VOC. Since 1974, 60 percent of the blowouts have lasted ≤ 1 day; and only 10 percent have lasted >7 days.

Oil spills are a second accidental source of gaseous emissions. The average size of a $\geq 1{,}000$-bbl OCS spill is 18,000 bbl for OCS platform spills and 22,000 bbl for OCS pipeline spills. Modeling predictions of hydro-hydrocarbon evaporation (Payne et al., 1984a,b; 1987) from a 50,000-bbl slick over 30-day periods estimate that approximately 15,500 bbl—or 2,164 tons—of hydrocarbon would evaporate (Table IV.A.3-1). Because approximately 10 percent of gaseous hydrocarbons are nonmethane VOC, 216.4 tons of VOC would be lost to the atmosphere. The movement of the oil slick during this time would result in lower concentrations and dispersal of emissions over an area several orders of magnitude larger than the slick itself. Under the Alternative I base case, one 50,000-bbl spill is assumed. The estimated probability of one or more spills occurring is 27 percent. Smaller spills $<1{,}000$ bbl occur more frequently than larger spills. The number of small spills estimated for the Alternative I base case is 49, totaling 555 bbl over the life of the field.

Gas or oil blowouts may catch fire. In addition, in situ burning is a preferred technique for cleanup and disposal of spilled oil in oil-spill-contingency plans. For catastrophic oil blowouts, in situ burning may be the only effective technique for spill control.

Burning could affect air quality in two important ways. For a gas blowout, burning would reduce emissions of gaseous hydrocarbons by 99.98 percent and very slightly increase emissions—relative to quantities in other oil and gas industrial operations—of other pollutants (Table IV.B.1.n-3). If an oil spill were ignited immediately after spillage, the burn could combust 33 to 67 percent of the crude oil or higher amounts of fuel oil that otherwise would evaporate. On the other hand, incomplete combustion of oil would inject about 10 percent of the burned crude oil as oily soot, plus minor quantities of other pollutants, into the air (Table IV.B.1.n-4). For a major oil blowout, setting fire to the wellhead could burn 85 percent of the oil, with 5 percent remaining as residue or droplets in the smoke plume in addition to the 10-percent soot injection (Evans et al., 1987). Clouds of black smoke from a burning 360,000-bbl-oil spill 75 km off the coast of Africa locally deposited oily residue in a rainfall 50 to 80 km inland. Later the same day, clean rain washed away most of the residue and allayed fears of permanent damage.

Based on qualitative information, burns that are two or three orders of magnitude smaller do not appear to cause noticeable fallout problems. Along the Trans-Alaska Pipeline, 500 bbl of a spill were burned over a 2-hour period "apparently without long-lasting effects" (Schulze et al., 1982). The smaller volume Tier II burns at Prudhoe Bay had no visible fallout downwind of the burn pit (Industry Task Group, 1983).

Table IV.B.1.n-3
Emissions from Burning 20 Metric Tons of Natural Gas per Day During a Blowout
(tons)

	Duration of Blowout		
	1 day	4 days	7 days
Total Suspended Particulates	0.009	0.04	0.06
Sulfur Dioxide	0.0003	0.001	0.002
Volatile Organic Compounds	0.004	0.02	0.03
Volatile Organic Compounds	0.004	0.02	0.03
Nitrogen Oxides	0.04	0.15	0.26

Source: Calculated from emission factors in Frazier, Maase, and Clark, 1977.

Table IV.B.1.n-4
Emissions from Burning Crude Oil
(tons)

	Size of Burn	
	10,000 Barrels	200,000 Barrels
Total Suspended Particulates[1]	130	2,600
Sulfur Dioxide[2,3]	86	1,720
Volatile Organic Compounds[2]	0.5	10
Carbon Monoxide[4]	89	1,780
Nitrogen Oxides[4]	3.8	76

Source: USDOI, MMS, Alaska OCS Region, 1990.

[1] Estimated as 10 percent of the total burn, less residue (Evans et al., 1987).

[2] Burning assumed to be the same as residual oil firing in industrial burners. Emissions calculated from factors in Frazier, Maase, and Clark (1977).

[3] Assumes a sulfur content of 2.9 percent.

[4] Emissions calculated from factors in Evans et al. (1986, 1987).

Coating portions of the ecosystem in oily residue is the major, but not the only, potential air-quality risk. Recent examination of polycyclic aromatic hydrocarbons (PAH's) in crude oil and smoke from burning crude oil indicates that the overall amounts of PAH change little during combustion, but the kinds of PAH compounds present do change. Benzo(a)pyrene, which is often used as an indicator of the presence of carcinogenic varieties of PAH, is present in crude-oil smoke in quantities approximately three times larger than in the unburned oil. However, the amount of PAH is very small (Evans, 1988). Investigators have found that, overall, the oily residue in smoke plumes from crude oil is mutagenic but not highly so (Sheppard and Georghiou, 1981; Evans et al., 1987). The Expert Committee of the World Health Organization considers daily average smoke concentrations of more than 250 $\mu g/m^3$ to be a health hazard for bronchitis.

Over the life of oil exploration, development, and production in the sale area, 50,000-bbl-oil spill could be set on fire accidentally or deliberately. Potential contamination of the shore would be limited because exploration, development, and production activities under the proposal would be at least 4.8 km (3 mi) offshore, with the exception of the oil-transport pipelines. Also, large fires create their own local circulating winds—toward the fire at ground level—that affect plume motion. In any event, soot produced from burning oil spills tends to slump and wash off vegetation in subsequent rains, limiting any health effects. Accidental emissions are, therefore, expected to have a minimal effect on onshore air quality.

(4) **Effects at Nikiski, Alaska, and West Coast Ports:** During tanker-loading operations at the Nikiski terminal, emissions would result from the tanker-exhaust stacks and fugitive losses. Stack emissions primarily would consist of SO_2, NO_x, and PM-10. Assuming 30 tanker trips per year to west coast ports using 45,000-DWT tankers, tanker-loading operations in the peak production year would result in an estimated 4 tons per year of SO_2, 3 tons per year of NO_x, 1 ton per year of PM-10, and 231 tons per year of VOC. There would be some additional VOC emissions resulting from storage of crude oil near the terminal. The VOC emissions could be mitigated substantially by the use of vapor recovery during loading operations. Air-quality effects from SO_2 and NO_x would be insignificant (pollutant concentrations resulting from the activities would be well within the ambient air quality standards and PSD incremental limits). Effects from VOC emissions also would be insignificant because of the low potential for ozone formation in the area.

The crude oil that is not transported to west coast ports would be processed at the Nikiski refineries. However, no increase in refinery throughput is expected, because it is assumed that the Sale 149 crude would displace North Slope oil that is currently received from the Valdez terminal. No change in refinery emissions is therefore expected.

During tanker-unloading operations at west coast ports, emissions of NO_x, SO_2, PM-10, and VOC would result from tanker-exhaust stacks and fugitive losses. The largest potential source would be fugitive VOC emissions. However, the use of segregated ballast on tankers and vapor recovery would mitigate most of these emissions. At most west coast port facilities, vapor recovery would be required that would reduce VOC emissions by at least 95 percent. The SO_2 emissions also would be reduced as a result of requirements of low-sulfur fuel during vessel operations in port. Because of the relatively low number of tankers that would visit a particular port, the mitigating requirements that are in place, and because it is expected that Sale 149 crude oil would displace at least part of the oil coming from other sources, no change in air-quality effects would be expected from tanker operations at west coast ports.

The tanker terminals in the Los Angeles Basin are located in a nonattainment area for ozone (the nonattainment status is classified as extreme). Gradual improvement in air quality is expected due to expected overall emission reductions required by the local regulatory agency, although attainment of the standard is not likely until the year 2010. Any emission increases due to tanker operations from Lease Sale 149 would have to be mitigated or offset, and would therefore have no effect on air quality in the region.

Conclusion: Effects on onshore air quality from Alternative I base-case air emissions are expected to be 20.4 percent of the maximum allowable PSD Class I increments. Only the Tuxedni National Wilderness Area is designated Class I, with the remaining area in and adjacent to the sale area designated Class II. Therefore, the potential effects would be much less. These effects would not make the concentrations of criteria pollutants in the onshore ambient air approach the air-quality standards. Consequently, a minimal effect on air quality with respect to standards is expected. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore due to exploration, development and production activities, or accidental emissions would not be sufficient to harm vegetation. A light, short-term coating of soot over a localized area could result from oil fires.

o. **Effects on Coastal Zone Management:** In the following paragraphs, the Statewide Alaska Coastal Management Plan (ACMP) standards and district policies of the Kodiak Island Borough and the Kenai Peninsula Borough are related to the potential effects identified throughout Section IV.B.1 of this EIS. District policies are assessed in conjunction with the Statewide standards most closely associated with it.

Recent amendments to the Coastal Zone Management Act (CZMA) provide that OCS lease sales must be consistent with the enforceable coastal management policies of affected states; however, this analysis is not a consistency determination pursuant to the CZMA, nor should it be used as a local planning document. It is unlikely that all of the hypothesized events would occur exactly as assumed in this EIS. Changes made by lessees as they explore, develop, and produce petroleum products from leases offered in this sale would affect the applicability of this assessment.

(1) **Coastal Development (6 AAC 80.040):** Water dependency is a prime criterion for development along the shoreline (6 AAC 80.040[a]). The intent of this priority is to ensure that onshore developments or activities that can be placed inland do not displace activities dependent upon shoreline locations. The only OCS developments or activities hypothesized in the scenario are the landfall site for the pipeline near existing facilities in Nikiski. This development is within the KPB. Only the landfall is assumed to be on the shoreline and, by definition, it requires a shoreline location.

State standards also require that the placement of structures and discharge of dredged material into coastal waters comply with the regulations of the U.S. Army Corps of Engineers (COE) (6 AAC 80.040[b]). Much of the development hypothesized in the scenario would be subject to COE regulations. None of the projects necessarily is allowed or disallowed under the provisions of the COE regulations. Site-specific environmental changes pursuant to development would be assessed and permitted depending on the attendant effects.

In addition, the KPB has four policies addressing coastal development that may be applicable (Kenai Peninsula Borough Coastal Management Program [KPB CMP] 2.4 through 2.7). These policies require that cumulative effects be considered and would guide the location and construction of the pipeline; regulate the dredging, filling, and disposal of dredged materials; and guide mitigation practices. Conflict between these policies and the hypothesized development activities is not inherent.

(2) **Geophysical-Hazard Areas (6 AAC 80.050):** The Statewide standard requires coastal districts and State agencies to identify areas in which geophysical hazards are known and in which there is a substantial probability that geophysical hazards may occur. Development in these areas is prohibited until siting, design, and construction measures for minimizing property damage and protecting against loss of life have been provided. The KPB CMP contains five policies that address geophysical hazards. They cover major considerations such as erosion; development in a floodway and floodplain; and landslides, mass wasting, and avalanches.

Geophysical hazards are described in Section III.A.1.c. Although earthquakes, shallow faults, volcanos, tsunamis and seiches, sediment/seafloor instability, gas-charged sediments, and large bedforms are evident in the sale area, the description of the hazards provided in Section III.A.1.c indicates that none seems to pose a high degree of risk to any development operation.

The MMS regulations, including the platform verification program, regulate lessees to ensure that geophysical hazards, such as those identified, are accommodated in the exploration and development and production plans that must be approved before lessees may commence activities.

(3) **Recreation (6 AAC 80.060):** Under this Statewide standard, districts are to designate areas for recreational use and give high priority to maintaining and, where appropriate, increasing public access to coastal water. The KPB CMP contains four policies guiding the location and use of public recreation (KPB CMP 4.1 through 4.4).

Effects on recreation were identified in Section IV.B.1.m. These effects primarily were indirect effects resulting from an oil spill and subsequent cleanup activities. Only one of the policies, KPB CMP policy 3.4(d)2, deals directly with conflict between other activities and recreational use of designated recreation areas. This policy directs other activities to be conducted to minimize conflicts. Oil spills, the primary factor affecting recreational opportunities, are not activities subject to direction by regulators or lessees; however, prevention of oil spills is an important factor in approving offshore activities. Regulations designed to prevent oil spills are addressed with respect to the ACMP Statewide standard for Air, Land, and Water Quality (Sec. IV.B.1.o[9]).

(4) **Energy Facilities (6 AAC 80.070)**: Associated with this lease sale are several facilities identified in the ACMP as uses of Federal and State concern. These include pipelines and rights-of-way; drilling rigs and platforms; petroleum separation, treatment, or storage facilities; and oil terminals and other port development for the transfer of energy products (6 AAC 80.900[22]). Moreover, "uses authorized by the issuance of state or federal leases for mineral and petroleum resource extraction are uses of state concern (6 AAC 80.070 [c])." A district may restrict a use of State concern only if the decision is reasonable and the district has consulted with and considered the views of appropriate agencies, identified reasonable alternative sites, and based its restrictions on analysis that shows the proposed use is incompatible with the proposed site (AS 46.40.070 [c]).

Statewide standards require that decisions concerning energy-related facilities be based, to the extent feasible and prudent, on 16 policies. The KIB CMP expands all but three of the Statewide standards to "encompass 'related activities' in addition to 'facilities'" (KIB CMP 5.1). The Statewide standards require that facilities be sited to (1) minimize adverse environmental and social effects while satisfying industrial requirements and (2) be compatible with existing and subsequent uses (6 AAC 80.070[1] and [2]). Expanding on these points, the Statewide standards further specify that facilities be sited in areas of least biological productivity, diversity, and vulnerability and that areas of particular scenic, recreational, environmental, and subsistence and/or cultural values be protected (6 AAC 80.070 (b)[13], and [12]).

Another Statewide standard requires that facilities be consolidated (6 AAC 80.070(b)[3]). The KPB CMP augments this and requires that "existing industrial facilities or areas and pipeline routes shall be used to meet new requirements for exploration and production support bases, transmission/ shipment (including pipelines and transportation systems), and distribution of energy resources" (KPB CMP 5.3).

Pipelines are emphasized in this Statewide standard and the KPB CMP. First, the Statewide standard requires that facilities be designed to permit free passage and movement of fish and wildlife with due consideration for historic migratory patterns (6 AAC 80.070 [12]). In addition, the KPB CMP requires that offshore pipelines and other underwater structures be located, designed, or protected to allow fishing gear to pass over without snagging or otherwise damaging the structure or gear (KPB CMP 5.5). Moreover, they shall "be sited designed, constructed, and maintained to avoid important fishing grounds and to minimize risk to fish and wildlife habitats from a spill, pipeline break, or other construction activities. Pipeline crossings of fish-bearing waters and wetlands important to waterfowl and shorebirds shall incorporate mitigative measures, to the extent feasible and prudent, to minimize the amount of oil which may enter such waters as a result of a pipeline rupture or leak" (KPB CMP 5.6). No barriers to migrating fish and wildlife were identified in the resource analyses as a result of development hypothesized in this EIS; however, some habitat damage is anticipated (Secs. IV.B.1.c through g). As stated in the KPB CMP policy, some mitigation measures will be required to minimize damage; however, nothing in the scenario is inherently in conflict with these policies.

Other siting criteria include: (1) Water discharges and oil spills must be able to be contained and damage to the environment (including fishing grounds, spawning grounds, and other biologically productive or vulnerable habitats, including marine mammal rookeries and hauling out grounds and waterfowl nesting areas) be minimized. (2) Winds and air currents must be able to disperse the emissions so Federal and State air-quality regulations are not violated. (3) Navigational hazards must be avoided. (4) Space must be available for reasonable expansion. (5) Sites must either have existing infrastructure or be appropriate for an enclave development (6 AAC 80.070 (b) (11), (13), (14), (8), (6), (7), respectively). In addition to oil spills, the KPB CMP 5.2.a includes drilling wastes and other toxic or hazardous materials as substances that commercial/industrial operations must prevent from contaminating surface and groundwater.

The KPB CMP policy 5.9 provides strict guidance for how and when geophysical surveys may occur and be consistent with the KPB CMP. "Seasonal restrictions, restrictions on the use of explosives, or restrictions relating to the type of transportation utilized in such operations will be included as necessary to mitigate potential adverse impacts" (KPB CMP 5.9 [a]). In addition, "[v]essels engaged in offshore geophysical exploration will conduct their operations to avoid significant interference with commercial fishing activities" (KPB CMP 5.9 [c]). It was noted in Section IV.B.1.i that fisheries employing pots, longlines, purse-seines, and drift-gillnets could be adversely affected by seismic surveys if seismic activities are not coordinated with the commercial-fishing industry.

The ITL No. 4, which encourages early consultation with affected coastal districts, ensures that site-specific criteria in the ACMP will be addressed at the time development is proposed and siting becomes specific. The analyses in this EIS indicate that the biological effects of oil spills and construction in the vicinity of the onshore facility would be local and of short duration. At this time, there is no inherent conflict between the siting of the pipeline and pipeline landfall and the KPB CMP policies and ACMP Statewide standards for siting energy facilities.

Construction associated with energy-related facilities resulting from Sale 149 also must comply with siting policies that apply to all types of development. These more general policies are discussed under Habitats (Sec. IV.B.1.o[8]) and Air, Land, and Water Quality (Sec. IV.B.1.o.[9]).

(5) **<u>Transportation and Utilities (6 AAC 80.080)</u>:** This Statewide standard requires that routes for transportation and utilities be compatible with district programs and sited inland from shorelines and beaches. In addition, the Statewide standard and related district policies identify constraints for the siting, design, construction, and maintenance of transportation and utility facilities. The KPB CMP requires that road, pipeline, and utility crossings of anadromous fish streams be minimized and consolidated at single locations (KPB CMP 6.2.a). Underwater pipelines must be buried or otherwise "allow for the passage of fishing gear, or the pipeline route shall be selected to avoid important fishing areas, and anadromous fish migration and feeding areas" (KPB CMP 6.4.c). In addition, upland "pipelines and utilities shall be installed underground in areas of high recreational or scenic value or intensive public use" (6.4.b). Other policies for transportation and utilities are comparable to the Statewide standard and district policies discussed for facility siting, e.g., bridges and culverts must allow for free passage and existing corridors must be used to the extent feasible and prudent (KPB CMP 6.2.b and 6.4.a).

Only the location of the landfall is subject to a siting decision—the offshore platform site is determined by the location of the resources and the facilities in Nikiski to which the oil would be piped already exist. Therefore, transportation issues related to the scenario for this lease sale are linked to the siting of energy-related facilities that was discussed in conjunction with the previous policy on energy-facility siting. The Alaska Supreme Court, in its decision in <u>Trustees for Alaska v. State</u>, No. 3945, noted that "until exploration is proposed and, in all likelihood, until and unless a commercially exploitable discovery is made, there will be no occasion for siting, designing or constructing transportation and utility routes." Some guidance to lessees related to transportation of hydrocarbons is provided in the stipulation on pipelines associated with this lease sale. In addition, the ACMP Statewide standards and district policies related to energy facilities and transportation and utilities will be helpful in guiding the decision on where to locate the landfall. However, nothing in the scenario is inherently in conflict with this Statewide standard and associated district policies.

(6) **<u>Fish and Seafood Processing (6 AAC 80.090)</u>:** This Statewide standard requires districts to identify areas of the coast suitable for the location or development of facilities related to commercial fishing and seafood processing and allows the district to designate such areas.

Although analysis in Section IV.B.1.c indicates that fish stocks are not expected to be adversely affected by development associated with this lease sale, commercial-fishing operations could be affected in the event of an oil spill. Such effects were documented following previous oil spills such as those of the *Exxon Valdez* and the *Glacier Bay*. Some nearshore effects can be minimized by careful siting of the offshore pipeline and landfall; however, spills along the tanker route associated with the platform or refinery in Nikiski, are not linked to a facility to be sited under this scenario. Nothing in the scenario is inherently in conflict with this Statewide standard and associated district policies.

(7) **<u>Subsistence (6 AAC 80.120)</u>:** Statewide standards guarantee opportunities for subsistence use of coastal areas and resources. Potentially conflicting uses or activities occurring within this designated area may be permitted only after (1) a study is conducted to determine possible adverse effects and (2) safeguards are implemented to ensure continued subsistence use. Although both coastal districts have policies that supplement the Statewide standard on subsistence, the analysis of effects on subsistence indicates that only

communities in the southern Kenai Peninsula, including the communities of Nanwalek and Port Graham, may experience periodic episodes of subsistence-resource loss, primarily as a result of oil spills associated with transporting oil to market. In addition to the Statewide standard, the KPB CMP contains four policies that address subsistence. These policies ensure that projects and uses in areas traditionally used for subsistence accommodate the use of subsistence resources from planning to operation, minimize adverse effects to subsistence resources and activities, and maintain access to subsistence-use areas (KPB CMP 11.1 through 11.4). These policies would guide the siting of the pipeline landfall; however, they would not preclude the effects that are related to unavoidable oil spills.

(8) <u>**Habitats (6 AAC 80.130)**</u>: The Statewide standard for habitats contains an overall standard plus policies specific to eight habitats—offshore areas; estuaries; wetlands and tideflats; rocky islands and seacliffs; barrier islands and lagoons; exposed high-energy coasts; rivers, streams, and lakes; and important upland habitat (6AAC 80.130 a, b, and c). Activities and uses that do not conform to the standards may be permitted if there is a significant public need and no feasible prudent alternatives to meet that need, and all feasible and prudent measures are incorporated to maximize conformance (6AAC 80.030 d).

The ACMP Statewide standard for all habitats in the coastal zone requires that habitats "be managed so as to maintain or enhance the biological, physical, and chemical characteristics of the habitat which contribute to its capacity to support living resources" (6 AAC 80.130 [b]). The offshore habitat is designated a fisheries conservation zone (6 AAC 80.130.[c][1]). The KPB CMP contains a policy that gives the highest priority to the maintenance and enhancement of fisheries when the districts evaluate projects that may effect fish spawning, migration, rearing, and over-wintering areas (KPB CMP 12.1). Although it is unlikely that an oil spill will affect areas within the Port Graham/English Bay Area Meriting Special Attention (AMSA), the AMSA Plan identifies seven sites that are considered a priority to protect from an oil spill (Port Graham/English Bay AMSA Plan 13.1).

Analyses in Section IV.B.1 indicate that neither habitat alteration and reduction nor noise and disturbance are expected to have long-term effects on lower tropic-level organisms, fishes, birds, marine mammals, endangered and threatened species, or terrestrial mammals. As a result, no conflict is anticipated with KPB CMP policies that address seabird colonies and marine mammal haulouts and bald eagles and their nest sites (KPB CMP 12.7 and 12.9, respectively). Further, it was noted that some disturbances associated with exploration and development would be mitigated by the Stipulations on Protection of Biological Resources and Density Restriction Related to Commercial Fishing Uses, and the ITL clauses concerning Bird and Marine Mammal Protection and Areas of Biological and Cultural Sensitivity (Sec. IV.B.1.e).

Seismic surveys may reduce the harvests in the purse-seine and gillnet fisheries if survey lines entangle buoy lines for crab pots or longlines or temporarily disperse pelagic fish (Sec. IV.B.1.i). These potential interactions between seismic activity and the fishing industry may be in conflict with the policies and Statewide standard for offshore habitat that designates the offshore area as a fisheries-conservation zone to maintain or enhance the State's commercial and subsistence fishery. The stipulation on Minimizing Potential Conflicts between Oil and Gas Industry and Fishing Activities will provide a means of communication between the two industries that will help to reduce potential gear conflicts.

Oil spills represent the greatest risk to the fishing industry and biological resources. The effects of oil spills depend on the location and time of year of the spill; therefore, the following summary is based on a spill location that varies to identify the greatest biological effects on each resource. Long-term negative effects typically are not anticipated as a result of this sale. However, biological resources may experience some level of effect as a result of an oil spill. Fishes would be most affected at the egg and larval stages, although population-level effects are not anticipated. Of the marine mammals, sea otters, harbor seals, and Steller sea lions likely would be the most affected. Steller sea lions may require a generation for the regional stock to recover from a spill that contacts a major rookery. Effects on Steller's eiders could require up to two generations to recover if a spill were to affect winter habitat. Because oil spills occur in spite of best management practices, some level of conflict with the habitat policies would be likely. However, habitats that are particularly sensitive can receive special protection under the ITL clause on Sensitive Areas to be Considered in the Oil-Spill-Contingency Plans.

(9) <u>**Air, Land, and Water Quality (6 AAC 80.140)**</u>: The air-, land-, and water-quality standard of the ACMP incorporates by reference all the statutes pertaining to, and regulations and procedures of, the Alaska Department of Environmental Conservation as of 1978. Those that have been implemented after that

date that are pursuant to the Clean Air Act and Clean Water Act (CWA) automatically are incorporated. In August, 1992, the Coastal Policy Council adopted a regulation to update this standard to include all DEC statutes, regulations, and procedures that have been enacted since 1978. The updated standard will be enforceable after the U.S. Department of Commerce, through NOAA, approves the revision.

Emissions into the air as a result of exploration and development associated with Sale 149 are not expected to approach the concentrations of criteria pollutants permissible under the air-quality standards. Permitted discharges into the water from exploration-drilling units and production platforms will be highest, and potentially above water-quality standards, during the time of the discharge—and shortly thereafter—in areas that generally are <2 km^2. Produced waters constitute the largest source of substances discharged into the marine environment and typically range in toxicity from almost nontoxic to slightly toxic.

Of greatest concern with respect to water quality is the potential for accidental releases of oil. The average size of the large oil spill assumed for the oil-spill model is 50,000 bbl. The maximum spill assumed in the event of a large spill is 109,000 bbl. This compares to 240,000 bbl of oil spilled when the *Exxon Valdez* went on the rock in 1989. Concerns about living resources affected by an oil spill are summarized under the Habitat standard. It is through the application of MMS regulations for Oil Spill Contingency Plans (30 CFR 250.42) and Training and Drills (30 CFR 250.43) and the emphasis on lessee responsibilities under these regulations in the ITL clause related to Oil-Spill-Response Preparedness that this concern and potential conflict with this Statewide standard is mitigated. No conflict is anticipated with the KPB CMP policy that requires the storage, treatment, and processing of petroleum products occur outside the 100-year floodplain and storage facilities for petroleum be surrounded by an impermeable berm and basin capable of retaining 110 percent of storage capacity plus 12 inches of free board (KPB CMP 13.2). Passage of the OPA 90 has made a number of changes to the regulatory system pertaining to oil and hazardous-material response. These changes and the implementation of improved oil-spill-cleanup capabilities are described in Sections IV.A.3 and 4.

(10) Statewide Historic, Prehistoric, and Archaeological Resources (6 AAC 80.150): The ACMP Statewide standard requires that coastal districts and appropriate State agencies identify areas of the coast that are important to the study, understanding, or illustration of National, State, or local history or prehistory. Although no disturbance of known sites is likely, previously undiscovered sites and artifacts may be encountered. The KPB CMP requires that the site be protected from further disturbance and the State Historical Protection Office be notified immediately to evaluate the site or artifacts (KPB CMP 14.2).

Chapter IV.B.1.1 and Appendix F provide the documentation that is required by the Alaska Supreme Court before the State can proceed with a lease sale (Trustees for Alaska v. State, No. 3945, April 23, 1993). In Appendix F, 149 blocks have been identified with a high probability for containing prehistoric resources (Appendix F, Fig. F-1). Nothing in the scenario that accompanies this lease sale would inherently conflict with the Statewide standard or the KPB CMP policy.

Summary: Many of the Statewide standards could apply to the hypothetical developments associated with the scenario for the base case. Those covered in the analysis include coastal development; geophysical-hazard areas; recreation; energy facilities; transportation and utilities; fish and seafood processing; subsistence; habitats; air, land, and water quality; and historic, prehistoric, and archaeological resources. Potential conflict with many of these Statewide standards and the associated district policies is unknown until a specific plan is submitted. This is particularly true for policies related to coastal development; geophysical hazards; energy facilities; transportation and utilities; and historic, prehistoric, and archaeology resources. However, a potential for conflict with the habitat standard was identified. The ACMP provides a format for mitigating potential conflicts. The MMS operating procedures and the mitigating measures associated with this sale, especially the ITL clauses for oil-spill-contingency response, bird and mammal protection, sensitive areas to be considered in oil-spill-contingency plans, and coastal zone management, and the stipulations on minimizing potential conflicts between oil and gas industry and fishing activities and the density restriction related to commercial fishing uses provide additional mechanisms to ensure that activities that may follow this sale avoid conflict with the ACMP.

Conclusion: Conflict with the habitat standard of the ACMP is possible. Conflict with the other standards is not inherent in the scenario.

2. **Alternative II, No Lease Sale**: This alternative would be tantamount to cancellation of Sale 149. As a result of such a cancellation, the 200 MMbbl of oil estimated to be produced in the base-case scenario would be neither discovered nor developed. Also, the environmental effects from the base-case proposal, as described in Section IV.B.1, would be eliminated. Should the sale be canceled, the energy that would have flowed into the U.S. economy from resources leased under this sale would need to be provided by substitute sources. These alternatives are addressed in Appendix D.

Possible substitutes for the resources expected to be produced as a result of the proposed action include:

1. Oil-supply substitutes
    - domestic onshore oil production
    - imported oil
2. Fuel substitutes in the transportation sector
    - imported methanol
    - gasohol
    - compressed natural gas
    - electric cars
3. Conservation
    - in the transportation sector
    - reduced consumption of plastics

The provision of energy resulting from this alternative likely would result from a mix of the substitutes listed above. The mix would depend on economic and regulatory factors as well as the short-run availability of capacity to produce and transport quantities of the various substitutes.

Likely environmental effects from this alternative might include:

- from onshore oil production—local air pollution, greenhouse gases, water contamination, land effects, and health risks;
- from increased oil imports—greenhouse gases, water contamination, and spill-related degradation of water and adjacent land areas (effects of oil transport are discussed in Sec. IV.B);
- from imported methanol—air-quality deterioration, water and land degradation, and health and safety risks;
- from production of ethanol to be used in gasohol blending—severe air pollution, significant water-quality degradation, extensive soil erosion and loss of wildlife habitat, and greatly increased areas devoted to landfills;
- from the natural gas used in compressed natural gas vehicles—both local and greenhouse gas pollution, water contamination, and land effects;
- from the electricity generated for use in electric cars—a variety of environmental effects that depends upon the type and location of the plant used to generate the electricity; and
- from conservation—only very minor negative environmental effects associated with the various approaches to petroleum-product conservation.

A more detailed discussion of alternatives to the expected oil production from this lease sale, along with their environmental effects, can be found in Appendix D. Appendix D also discusses possible alternatives to natural gas in the unlikely event that natural gas from the lease-sale area is ever commercially produced. Tables D-3 and D-4 show the equivalent quantities of alternative energy sources that may be required should this lease be canceled.

Cancellation of the lease sale also could mean that the quantities of North Slope oil currently transported by tanker from the TAPS terminal at Valdez to the refinery at Nikiski would continue at present or increasing levels. Production from proposed Sale 149 could back out some of the crude oil transported into Cook Inlet from Valdez. Accordingly, if the proposed action were to occur, one of the results could be a reduction in tanker traffic transiting from Valdez to Cook Inlet along the eastern and southern coastlines of the Kenai Peninsula. The Valdez to Nikiski tanker traffic passes relatively nearshore along the Kenai Peninsula, compared to oil transported from the proposed action, which would pass from Cook Inlet through the Kennedy Entrance directly to the Gulf of Alaska. Given the nature of ocean dynamics and nearshore currents along the Kenai Peninsula, oil spilled within the shore zone will tend to have a much greater area of contact than oil spilled away from shore in the Gulf.

Given the assumptions in the transportation scenario of the base case of the proposed action: 66 percent of all oil produced by the base case of the proposed action would be shipped out of State for processing on the west coast of the United States, and 34 percent would be retained for consumption within Alaska. Under this assumption, it is estimated that, averaged over the life of the field, 14 percent of the annual 25 MMbbl of oil transported from Valdez to Nikiski would not be shipped. Should the entire quantity of resources attributed to the base case of the proposal be processed in Nikiski for consumption in Alaska, an average of 42 percent of Valdez-to-Nikiski oil transport no longer would be necessary. Finally, should the resources of the high case of the proposal (800 MMbbl) be located, the potential arises for eliminating all Valdez-to-Nikiski crude oil shipments.

Conclusion: The effects described for the base case of the proposal would be eliminated by this alternative. However, cancellation of the sale would mean that the energy that would have flowed into the U.S. economy from resources leased under this sale would need to be provided by substitute sources. The energy probably would derive from a mix of sources, each of which has negative environmental effects associated with its production and transportation.

3. **Alternative III, Delay the Sale:** Please refer to the scenario discussion for the base case. The base-case scenario would be operable for this alternative; however, the timeframe would be delayed 2 years.

a. **Effects on Water Quality:** It is anticipated that the types and levels of activities associated with exploiting the potential petroleum resources in lower Cook Inlet following a 2-year delay would be the same as those hypothesized for Alternative I (base case). Also, estimates of the number of accidental oil spills and the amount of oil spilled are assumed to be the same as those of the base case. The potential effects in any of the areas where there are permitted discharges would last for about (1) 2 to 3 months for exploration-well drilling, (2) 1 month for pipeline construction, and (3) 21 years for development and production activities; the concentrations of released substances would be highest in areas that generally are <2 km^2 during the discharge period.

The activities associated with petroleum exploitation that are most likely to affect water quality for Alternative III are (1) the permitted discharges from exploration-drilling units and production platforms, (2) oil spills, and (3) construction activities. The USEPA guidelines for issuing discharge permits require a determination that the permitted discharges will not cause unreasonable degradation of the marine environment.

Conclusion: The permitted, routine discharges associated with oil and gas development and small (<1,000-bbl) oil spills are not expected to cause any measurable overall degradation of Cook Inlet water quality. Water quality would be reduced from good (unpolluted) to polluted by the presence of hydrocarbons from one or more large (≥1,000-bbl) oil spills that have a relatively low chance (27%) of occurring. Contamination (the presence of hydrocarbons in amounts >15 μg/l) would be temporary (last for a month, or more) and affect an area of several thousand square kilometers.

b. **Effects on Lower Trophic-Level Organisms:** Alternative III would delay any activities on the OCS. This would allow some extra time to gain additional studies information on lower trophic-level organisms. However, because of the amount of information available at this time and the shortness of the delay (2 years), the effect of this alternative on lower trophic-level organisms is expected to be similar to that of the base case (Sec. IV.B.1.b), as summarized below.

The base case could affect lower trophic-level communities (phytoplankton, zooplankton, and benthic) by exposing them to seismic surveys, discharged drilling muds, dredging or construction activities, and petroleum-based hydrocarbons. Seismic surveys are expected to have little or no effect on lower trophic-level organisms. Drilling discharges are estimated to affect (mostly sublethal effects) <1 percent of the benthic organisms in the sale area and none of its plankton. Recovery is expected to occur within 1 year. Dredging and construction are expected to have little or no effect on plankton communities, and <1 percent of the immobile benthic organisms would be affected (mostly sublethal effects).

Based on the assumptions discussed in the text (see Sec. IV.B.1.b), the assumed oil spill for the base case is estimated to have sublethal and lethal effects on 1 to 3 percent of the phytoplankton and zooplankton populations in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. The total percentage of plankton affected could increase to 5 percent if many embayments were contacted by the spill. Recovery within the affected embayments is expected to take 1 to 2 weeks. Marine plants and invertebrates in subtidal areas are not likely to be contacted by an oil spill, but marine plants and invertebrates in intertidal and shallow subtidal areas are likely to be contacted by an oil spill. Based on the assumptions discussed in the text (Sec. IV.B.1.b), the assumed oil spill for Alternative III is estimated to have lethal and sublethal effects on about 20 to 30 percent of the intertidal and shallow subtidal marine plants and invertebrates in the sale area. Recovery of these communities is expected to take 2 to 3 years in high-energy habitats and up to 7 years in lower energy habitats. Small oil spills (estimated total of 555 bbl) may adversely affect individual lower trophic-level organisms in small areas immediately around the spills. However, they are not expected to have perceptible effects on lower trophic-level organisms at the population level.

Conclusion: Effects due to the assumed oil spill are estimated as sublethal and lethal on 1 to 3 percent of the phytoplankton and zooplankton populations in the open-water areas of the sale area. Another 2 percent of the sale area's plankton population may be affected because of embayments being contacted, bringing the total up to 5 percent. Lethal and sublethal effects are estimated on about 20 to 30 percent of the intertidal and shallow subtidal marine invertebrates in the lower Cook Inlet area. Recovery of these communities is expected to take 2 to 3 years in high-energy habitats and up to 7 years in lower energy habitats.

c. **Effects on Fisheries Resources**: Effects associated with this alternative are expected to be essentially the same as those discussed for the base case (Sec. IV.B.1.c). The magnitude of the effects would vary, depending on the population status of affected fisheries resources at the time the delay would terminate or when the effects would occur. Delaying the sale would provide additional time for research, which would improve the assessment of effects of the proposal on fisheries.

As discussed in the base case, sale-specific oil-spill effects are not expected to directly affect returning adult salmon or steelhead. Oiled intertidal areas could cause an increased mortality to pink salmon eggs in the affected areas. There may be an increased level of developmental malformations and increased egg-larval mortality in herring. Eggs and larvae of some semidemersal and demersal fishes may suffer increased mortality from oil contact. Some demersal fish populations could be exposed to oil in the event of a spill, and a few individuals may die.

Indirect effects such as ingesting oil from contaminated food could cause slower growth of pink salmon juveniles and possibly some incremental reduction in survival to adulthood, but it is not expected to have population-level effects.

Fisheries resources could be disturbed and displaced from the immediate vicinity of drilling discharges, but this likely would be limited to only the short time periods of the discharge. Offshore construction also could temporarily disturb and/or displace fisheries resources. Any disturbance or displacement should be short term (hours to days), limited to only the time of construction and shortly thereafter. Seismic surveys probably would have no appreciable adverse effects on fish populations.

Conclusion: An oil spill would have no appreciable adverse effects on adult pelagic fishes. Eggs and larvae of pink salmon and semidemersal and demersal fishes could suffer increased mortality. Such mortality is not expected to have a population-level effect on pink salmon but may cause a reduction in survival of an entire herring year-class. Some individual demersal fishes are expected to be killed by the spill, but this mortality is not expected to affect demersal fish populations. Fisheries resources are expected to be temporarily disturbed and displaced by drilling discharges and offshore construction. These disturbances should be short term (hours to days). Seismic surveys may damage some eggs and larvae, but the injury is not expected to cause population-level effects.

d. **Effects on Marine and Coastal Birds**: Effects associated with Alternative III essentially are expected to be the same, at least qualitatively, as those discussed for the proposal (Sec. IV.B.1.d). The magnitude of any possible effects could vary, depending on the population status of affected bird species at the time the delay would terminate. Delaying the sale would provide additional time for ongoing research to acquire data useful for improving the knowledge and accuracy of effect prediction relative to habitats of marine and coastal birds.

Noise and disturbance would come from air (60-120 flights/month) and marine-vessel (60 trips/month) traffic and offshore habitat alteration (a few square kilometers) from offshore pipeline laying and installation of exploration and three production platforms. These effects are expected to be local (within 1 mi of the traffic, platform, and pipelines) and short term (<1 hour for air- and vessel-traffic-disturbance events to <1 year for pipeline- and platform-construction activities). Oil-spill effects on marine and coastal bird populations or portions of populations within the region are expected to include the loss of several thousand birds with full recovery from the spill to take more than one generation (probably <3 generations or <15 years), particularly on murre populations, which are expected to suffer substantial mortality (several thousand losses) from the assumed oil spills. The assumed 50,000-bbl spill is expected to contact coastal intertidal habitats and local food sources of sea ducks and shorebirds in lower Cook Inlet. This contamination is expected to result in reduced productivity (reproduction) of portions of the sea duck and/or shorebird populations through the ingestion of petroleum hydrocarbons on and within food items (such as mussels). The contamination is expected to persist for several years after the spill, and bird reproduction is expected to be affected for >1 year.

The overall effect of the proposal is expected to involve the loss of several thousand—to perhaps 100,000—birds from the spill, with recovery taking place within a few years to more than one generation (probability <3 generations or 15 years), depending on the status of the affected populations during the time of the spill. This conclusion was based on the high sensitivity of birds to an oil spill and the assumption that a 50,000-bbl spill will occur; the habitats and populations of marine and coastal birds most expected to be affected was determined by the combined probabilities ≥5 percent and conditional probabilities ≥50 percent assumed to occur along the tanker route. The general threshold for both combined and conditional oil-spill probabilities for assuming contact was ≥1 percent.

Conclusion: A delay of 2 years would not change the overall effect on marine and coastal birds, which is expected to include the loss of perhaps as many as 100,000 birds (primarily due to the assumed oil spill), with recovery taking more than one generation (probably <3 generations or <15 years). Sea ducks and shorebirds still are expected to suffer reduced productivity in areas where intertidal-habitat contamination from the spill persists for a number of years, with the effect to last >1 year.

e. Effects on Nonendangered Marine Mammals (Pinnipeds, Cetaceans, and the Sea Otter): Effects associated with Alternative III are expected to be essentially the same as those discussed for the base case (Sec. IV.B.1.e). The magnitude of the effects would vary, depending on the population status of affected marine mammal species at the time the delay would terminate, or when the effects would occur. Delaying the sale would provide additional time for research, which would improve the assessment of effects of the proposal on marine mammals.

As discussed in the base case, sale-specific oil-spill effects (assuming that a spill occurs and contacts marine mammals) include potential mortalities of <10 fur seals and killer whales, respectively; approximately 43 beluga whales; approximately 60 harbor seals; and between 75 to 100 sea otters. Recovery to prespill numbers was estimated to occur in about 1 to 2 years, with the exception of beluga whales, where recovery may require up to 7 years.

Effects to marine mammals due to noise and disturbance are estimated to be minimal. Seismic noise created by industry activity was identified as the loudest noise source. Sounds generated by seismic surveys probably would not affect harbor and fur seal and sea otter activities. Effects on the minke whale have not been studied but likely would be similar to effects on other baleen whales, which generally are tolerant of seismic pulses. Subtle behavioral changes may occur on occasion at low-sound levels, with stronger avoidance reactions when sound levels reach 160 to 170 dB, or higher. Toothed whales probably would be unaffected.

Low-altitude aircraft overflights can cause pinnipeds to stampede into the water. This may increase pup mortality during the pupping season. Both baleen and toothed whales usually respond to low overflights by diving. Reactions of pinnipeds and cetaceans vary by aircraft type, altitude of flight, and circumstances of the animals. These disturbance reactions usually are short term, with seals reoccupying haulouts and whales continuing their activities usually within a matter of hours.

The effects of habitat alteration/degradation associated with construction of pipeline and transport facilities would be limited to temporary disturbance to some sea otters and harbor seals in the nearshore environment. This disturbance likely would be relatively short term and very localized and should not affect survival.

Marine mammal disturbance associated with exploration and development would be reduced by the mitigating measures described in Section II.H.

Conclusion: Sale-specific oil-spill effects suggest Tuxedni Bay (ERA 1) and outer Kamishak Bay, including Augustine Island (ERA 4), have the highest probability of occurrence and contact of one or more ≥1,000-bbl spills during the life of the proposal. Fur seal mortality was estimated at <10 seals and was not expected to have a population-level effect. Harbor seal mortality was estimated at 60 seals and was not expected to have a population-level effect. Effects on killer whales were estimated at fewer than five killer whale mortalities, with recovery to prespill numbers estimated at 1 year, but allowing that age and social structure may take longer to recover. Estimated beluga whale mortality was 43 belugas, with recovery estimated to prespill numbers in 7 years. Minke whales, Dall's porpoises, Pacific white-sided dolphins, and harbor porpoises were estimated to be unaffected by a spill or, alternatively, the effects would be unmeasurable. Estimated sea otter mortality would be about 75 to 100 of the approximately 1,000 sea otters resident to Kamishak Bay. Recovery was estimated at about 1 to 2 years.

Seismic noise is expected to have minimal effects (local avoidance) on nonendangered marine mammals. Overflight-disturbances would be reduced by in-place mitigating measures and displacement effects probably would be short term, with seals reoccupying haulouts and whales continuing their activities usually within a matter of hours. Noise, disturbance, and habitat alteration/construction activities would be relatively short term and very localized and should not affect marine mammal survival.

f. Effects on Endangered and Threatened Species: Effects associated with this alternative are expected to be essentially as determined for the Alternative I (Sec. IV.B.1.f). These include brief minor behavioral responses by threatened or endangered species to disturbing activities, sublethal effects of spilled oil on whales and most Steller sea lions exposed, and some sea lion and Steller's eider mortality requiring at least one generation for recovery. The magnitude of effect would vary, depending on the population status of affected endangered or threatened species at the time the delay would terminate, or when the effects would occur. Delaying the sale would provide additional time to complete ongoing and proposed research. In particular, progress on several projects relating to the recent precipitous decline of the regional Steller sea lion population, and declines in the Steller's eider population, is expected to clarify the factors responsible for these situations and thereby facilitate a more rigorous assessment of potential effects of the proposed lease sale. Also, a proposed Cook Inlet water-quality program will determine baseline conditions in this area, potentially improving the assessment of effects of the proposal on endangered and threatened species.

Conclusion: The overall effect of exposure of endangered whales to disturbance and contaminants within or outside the proposed sale area is expected to be minimal; no mortality is expected to result from this lease sale. The effects of exposure of Steller sea lions to disturbance and minor contaminants within or outside the sale area are expected to be minimal; mortality resulting from an oil spill is expected to require at least one generation for recovery. The effects of this sale on the short-tailed albatross, Aleutian Canada goose, and peregrine falcon within or outside the sale area are expected to be minimal. The effect of a spill on Steller's eiders wintering near the sale area is expected to require up to two generations for recovery. Because the estimated probability of tanker-spill occurrence is only 6 percent, the risk of Sale 149 on species in the vicinity of southern tanker routes is considered to be negligible. Any large spill involving oil from the Sale 149 area is expected to result in effects as discussed above under the individual species' accounts.

g. Effects on Terrestrial Mammals: Effects on terrestrial mammals associated with Alternative III are expected to be the same, at least qualitatively, as those discussed for the proposal (Sec. IV.B.1.g). The magnitude of the effects would vary, depending on the population status of affected mammal species at the time the delay would terminate, or when the undesirable effects would occur. Delaying the sale would provide additional time for ongoing research (for example, National Park Service research on coastal habitats of Katmai National Park) to acquire data on the coastal distribution and habitats of terrestrial mammals useful in improving the accuracy and precision of effect prediction relative to terrestrial mammals.

Noise and disturbance effects from air (60-120 helicopter trips/month) and marine-vessel (60 boat trips/month) traffic are expected to have short-term- (a few minutes to <1 hour) displacement effects on brown bears, moose, and other terrestrial mammals within about 1 mi of the traffic routes when nearshore. The assumed 50,000-bbl-oil spill is expected to result in the loss of a small number of river otters (perhaps ≤60) and a small number of brown bears (perhaps ≤10) and some Sitka black-tailed deer (<100). More river otters (≥100) and brown bears (perhaps ≥30) are expected to be affected by the spill through contamination of intertidal habitats and prey, with this effect lasting for >1 year (perhaps 3 years). The possible loss of deer from the spill is expected to be replaced by population recruitment within about 1 year. Regional populations of river otters, brown bears, Sitka black-tailed deer, and other terrestrial mammals are not expected to be affected by the oil spill, or by the overall effect of exploration and development activities associated with the proposal.

Conclusion: The overall effect on terrestrial mammals is expected to include the loss of small numbers of river otters (<50), brown bears (<10), and black-tailed deer (perhaps ≤100) directly killed by the assumed oil spill. Total recovery of river otters and perhaps brown bears and their habitats is expected to take >1 year (perhaps 3 years), while the potential loss of black-tailed deer is expected to be replaced within 1 year.

h. Effects on the Economy: For Alternative III, the effects on the economy described for the base case would occur but at a later time. Increased employment is the most significant economic effect generated by the proposal. Employees would work on the construction, operation, and servicing of facilities associated with the sale. Direct OCS resident employment level varies from 734 to 756 from the year 2004 through 2020. Indirect resident employment is estimated to be 12.6 percent of direct OCS-resident employment and would peak at 162 for the year 2001. Between the years 1997 and 2003, direct OCS employment and indirect employment would increase and decrease, resulting in changes of between 0 and 3 percent each year. The effect of OCS employment on the average income would be a <3-percent change for <5 years. The increase in employment and average income translates to a price inflation of <3 percent for <5 years for western Kenai Peninsula. Revenue from property tax would increase <2 percent for <5 years for the KPB. The value of taxable improvements to property during a peak year is estimated to be $50 million (1993 dollars), which is 1.6 percent of the total taxable valuation for the KPB in 1993. Annual property-tax revenue of $2.2 million would accrue to the KPB and $0.4 million (1993 dollars) to the State after all major improvements are constructed or installed, which would be 2002. The improvements are estimated to be $100 million for shore-base improvements and $80 million for 800 new housing units. A spill resulting from activity associated with Sale 149 could generate 5,000 jobs for cleanup workers for the first year but would decline to zero by the fourth year. Housing rents in the western Kenai Peninsula probably would double for 1 year following a major spill.

Conclusion: This alternative would generate changes between zero and 3 percent in resident employment, <3 percent in average income, <5 percent in cost of living, <2 percent in property tax, and <5 percent in sales taxes on the western side of the Kenai Peninsula annually for <5 years. Property-tax revenues of $2.2 million for the KPB and $0.4 million (1993 dollars) for the State would be added annually after the year 2002. A large oil spill would generate 5,000 cleanup jobs for 6 months in the first year, declining to zero by the fourth year following the spill. Local communities would experience a doubling of housing rents for 1 year.

i. **Effects on Commercial Fisheries:** Alternative III would delay any activities on the OCS. This would allow some extra time to gain additional information on commercial fisheries, particularly the effects of oil spills (e.g., the EVOS) on commercial fisheries. However, because of the shortness of the delay (2 years), the effect of this alternative on commercial fisheries is expected to be similar to that of the base case (Sec. IV.B.1.i), as summarized below.

Drilling discharges associated with the base case are not expected to have an effect on commercial fishing due to the limited area affected near the platform-discharge point. Offshore construction, platforms, and pipelines are expected to result in some space-use conflicts (e.g., competition for docking space or gear loss); however, these are expected to be few in number and minor in scope. Seismic surveys, planned and coordinated with the commercial-fishing industry, are expected to have a minimal effect on the Cook Inlet commercial-fishing industry.

Due to the relatively small amount of oil involved (555 bbl), small oil spills are not expected to result in closures or reduced market values over the life of the proposal. The estimated economic effect of the large (50,000-bbl) oil spill on the Cook Inlet commercial-fishing industry is based on what occurred during the *Exxon Valdez* and *Glacier Bay* oil spills, and primarily depends on the highly variable EVOS cost estimates (ranging from $9 to $43 million/year for 2 years). From 1983 to 1993, the value of the Cook Inlet commercial fishery appears to have ranged between about $50 and $135 million/year.

Based on the above, in any 2-year period when the value of the Cook Inlet commercial fishery is estimated to be about $50 million/year, a 2-year loss of about $9 million/year represents an 18-percent/year loss for 2 years, whereas a 2-year loss of about $43 million/year represents an 86-percent/year loss for 2 years. In a 2-year period when the value of the Cook Inlet commercial fishery is estimated to be closer to $135 million/year, a 2-year loss of about $9 million/year represents a 7-percent/year loss for 2 years, whereas a 2-year loss of $43 million/year represents a 32-percent/year loss for 2 years. Because the occurrence of a large oil spill would preclude any knowledge of what the commercial fishery would have been worth, the value of the commercial fishery at the time of the assumed 50,000-bbl-oil spill is assumed to be the average annual value (1983-1993) of the Cook Inlet commercial fishery. Thus, in terms of the average annual value of the Cook Inlet commercial fishery (about $65 million), the assumed base-case oil spill is estimated to result in an economic loss of about 15 to 65 percent/year for 2 years. Estimated losses to the Kodiak commercial-fishing industry are expected to be less than half of that estimated for Cook Inlet, or about 5 to 25 percent/year for 2 years following the assumed 50,000-bbl Cook Inlet oil spill. This amounts to an estimated loss of about $4 to $19 million/year to the Kodiak commercial-fishing industry. However, the EVOS experience has demonstrated that compensation to the commercial-fishing industry for participating in the cleanup of a large Cook Inlet oil spill is likely to exceed these economic losses by several orders of magnitude.

Conclusion: Based on the assumptions discussed in the text, EVOS-loss estimates, and the average annual value of the Cook Inlet and Kodiak commercial fisheries, Alternative III is estimated to result in economic losses to the

Cook Inlet commercial-fishing industry ranging from about 15 to 65 percent/year for 2 years following the assumed 50,000-bbl oil spill. Losses to the Kodiak commercial-fishing industry from the same spill are estimated to range from about 5 to 25 percent/year for 2 years following the spill.

j. **Effects on Subsistence-Harvest Patterns:** Alternative III would delay for 2 years the effects on subsistence-harvest patterns associated with the proposal. Under the proposal, effects on subsistence-harvest patterns would be most prominent among southern Kenai Peninsula communities, including the communities of Nanwalek and Port Graham. These communities would experience subsistence-resource loss, primarily because of the high level of exposure to spills from transportation segments. Such losses would include the lack of resource availability, accessibility, or desirability for use. Based on the EVOS experience (see Sec. III.C.3), harvest-level reductions estimated at 30 to 50 percent of average annual yields could occur in the first year of a spill, with substantial recovery thereafter.

Elsewhere in Cook Inlet and on Kodiak Island and the Alaska Peninsula, effects on subsistence-harvest patterns are estimated to be limited in magnitude and duration and not of such a nature as to cause measurable changes in the availability, accessibility, or desirability of most subsistence resources.

Conclusion: Although delayed for 2 years, subsistence harvests in the base case would be reduced or substantially altered by as much as 50 percent in one or more southern Kenai Peninsula communities for at least 1 year and to a lesser extent for selected subsistence resources 2 to 3 years beyond.

k. **Effects on Sociocultural Systems:** Alternative III would delay for 2 years the effects on sociocultural systems associated with the proposal. Effects on sociocultural systems begin with the prelease processes of announcing the proposed sale and carrying out the preparation of an EIS. Given a significant oil discovery, planning processes are again engaged to prepare a developmental EIS. Each of these sometimes lengthy processes causes stress and anxiety among affected publics, although the stakes would be different. The discussion under the base case (Sec. IV.B.1.k.) explores the types of impacts involved.

Under the proposal, effects on sociocultural systems are centered on the Kenai Peninsula, including the Alutiiq communities of Nanwalek and Port Graham. Resident population associated with the sale would do little to change existing sociocultural systems in the central Kenai Peninsula area, where new resident population would be expected to live. There is an estimated 27-percent chance that one or more oil spills ≥1,000 bbl would occur and an estimated 26-percent chance that such a spill would occur and contact land within 30 days; the individual, social, and institutional effects would be serious. Individual and social stress and anxiety levels would be expected to increase in southern Kenai Peninsula communities over the loss of subsistence resources, contamination of habitat, fear of the health effects of eating contaminated wild foods, and the need to depend on the knowledge of others about environmental contamination. In the Alutiiq communities, the organization of subsistence activities among kinship and friendship groups and the relationships among those that customarily process and share subsistence harvests also would be modified and could decline in importance. Stress-induced increases in alcohol and drug abuse would produce increases in numerous substance-abuse problems, such as child abuse, domestic violence, and accidents. The duration of individual and social effects would depend on the severity of the oil-spill experience. Institutionally, communities would undergo considerable disruption and community conflict, with litigation constituting a secondary source of postspill social and community stress.

Conclusion: Although delayed for 2 years, sociocultural systems in one or more southern Kenai Peninsula communities would undergo periodic episodes of increased individual, social, and institutional stress and disruption that would last for several years in each instance and endure in memory for decades; effects are caused by both prelease and potential postlease processes and events.

l. **Archaeological and Cultural Resources:** Effects on submerged archaeological resources may result from disturbance to shipwrecks, prehistoric sites, and historic sites (Sec. III.C.5) by activities such as laying pipelines, dragging anchors of operating and supply vessels, and anchoring drill rigs. Onshore prehistoric and historic sites may be affected by construction of pipelines, onshore-support facilities, increases in industrial personnel and supporting populations, and through accidental disturbance. The routine disturbances would be mitigated.

Oil spills (from supply vessels) for drilling operations are not expected to be large. These require only small cleanup operations and would not involve bulldozers, trucks, and other heavy equipment to be moved to the oil-spill-cleanup area. Only the direct effects from oil spills and the indirect effects of oil-spill-cleanup operations and the potential for increased vandalism of archaeological sites by oil-spill-cleanup crews and support populations cannot be effectively mitigated.

Effects on archaeological resources (prehistoric archaeological sites, historic sites, and shipwrecks within Alaska's 3-mi zone) are due to activities of exploration and development personnel and other indirect increases in population brought on by exploration, development, and oil-cleanup activities. Effects on Kenai, Kachemak Bay, Kodiak, and the Alaska Peninsula onshore archaeological resources and offshore resources are expected to be such that <3 percent are affected. The effects of cleanup activities, vandalism, and wear and tear on archaeological sites over the duration of the lease also are not expected to exceed effects found in the EVOS case study on archaeological resources.

Conclusion: The effects of delaying the sale for 2 years would be the same as the base case on submerged archaeological resources, historical resources, and submerged offshore shipwrecks and are expected to be effectively mitigated. It is expected that the effects of cleanup activities, vandalism, and wear and tear on archaeological sites and shipwrecks on the shore and within the State's 3-mi zone over the duration of the lease would affect <3 percent (an estimated <30 sites) of those resources.

m. Effects on National and State Parks and Related Recreational Places: The effects on these resources from Alternative III would be the same as the effects shown for the base case, except that they would be delayed 2 years.

Any closure of water-oriented recreational facilities would be for short periods only due to cleanup of small oil spills. In particular, trends for visitors to national parks and refuges would show a slight loss during the year after a spill (Fig. III.C.6-2) in spite of industrial support of extensive advertising in other States to bring tourists to Alaska. These rates would continue to fall in the year following for Lake Clark but not for Katmai. A slight decrease in park visitors is expected for large spills but not for small spills. Recreational fishing would drop slightly in areas affected by a spill (1 or 2 years). A decline in spending by visitors would be in proportion to the decline in the number of visitors. Because the recreation and tourism facilities of the Kenai Peninsula already are crowded during the summer season, the additional population due to OCS activities will add somewhat to the congestion at recreational and tourism areas. Steps are being taken at Federal, State, and local levels to increase recreational opportunities; but the problem will continue to exist, and the proposal does add slightly to the problem. However, over the life of the proposal (30 years), the addition is minimal. At any time of the year, public water-oriented recreational facilities in parks, refuges, and recreational areas could be closed for a short time because of oil-spill-cleanup activities.

In the land segments discussed above due to the risk, which for the combined probability estimates is <2 percent, and due to the level of activity in this scenario, an estimated <3 percent of the resources would be altered for the 3-year period and would recover after that time.

Conclusion: Effects are expected to reduce visual qualities of the parks and related recreational places very slightly, reduce visitor rates to those parks and related recreational places minimally, and affect the physical and biological resources (<3% of resources affected) for about 3 years. In particular, trends for visitors to national and State parks and related recreational places would show a slight loss during the year after a spill. The rates would continue to fall in the year following for Lake Clark but not for Katmai. A slight decrease in visitors is expected for large spills but not for small spills. Recreational fishing would drop slightly in areas affected by a spill for a year or two after the spill. A decline in spending by visitors would be in proportion to the decline in the number of visitors.

n. Effects on Air Quality: Air-quality regulations and procedures are discussed in Section IV.B.1.n, the base case. That discussion also describes the methodology used to model the air-quality effects associated with this proposed lease sale. The USEPA-approved OCD model was used to calculate the effects of pollutant emissions from the proposal on onshore air quality. Because the Class I PSD areas allow for the least amount of degradation, the modeling scenario (i.e., source location) chosen for this analysis is the one that results in the maximum potential effect to the air quality of the designated national wilderness area of the Tuxedni National

Wildlife Refuge, the only Class I area adjacent to the proposed sale area. The maximum-potential effect at any location in the Class II area would be the same. In all likelihood, effects to the Tuxedni National Wilderness Area would be lower than those calculated by the model. Under this alternative, the proposed sale would be delayed for a period of up to 2 years.

Conclusion: The effects associated with this alternative essentially would be the same, qualitatively, as those discussed for the Alternative I base case, only delayed for 2 years.

o. Effects on Coastal Zone Management: Delaying the sale for 2 years would not alter the effects of the lease sale; therefore, the potential for conflict with the enforceable policies of the ACMP would remain the same as for the base case. Delay would provide additional time to enable the State to submit the ACMP amendment to NOAA updating the effective date of the air-, land-, and water-quality standard (6 AAC 80.140) and for NOAA to take action on the amendment.

Conclusion: Conflict with the habitat standard of the ACMP is possible. Conflict with the other standards is not inherent in the scenario.

4. Alternative IV, Wildlife Concentration Deferral Alternative:

Description of Alternative IV: This alternative would offer for leasing all the area described for Alternative I except for areas located near the Chisik and Duck Islands (Tuxedni Bay) and the Barren Islands (Fig. II.D.1). Chisik and Duck Islands are part of the Alaska Maritime National Wildlife Refuge and constitute the largest seabird colony in Cook Inlet. The intent of this alternative is to eliminate OCS activity, except for transportation, in the buffer zones near the aforementioned areas, thus reducing the possibility of an oil spill due to drilling activity.

The areas removed by the deferral alternative consist of (1) 34 partial and whole blocks located east of Tuxedni Bay and (2) about 18 blocks west of the Barren Islands. (The total area recommended for inclusion in the area proposed for deferral consists of 52 partial and whole blocks [241,377.9 acres].) Alternative IV would offer for lease 351 blocks.

Resource Estimates and Basic Exploration, Development, and Production Transportation Assumptions for Effects Assessment: The resources calculated for this alternative are expected to be 160 MMbbl of oil. The resource levels forecast for this alternative are approximately 20 percent less than those for Alternative I. Accordingly, the scenario analysis developed for the base-case-proposal discussion also is appropriate for Alternative IV. As indicated in Table II.A.1-1, the primary difference between the base-case proposal and this alternative is that Alternative IV has one fewer exploratory well and 15 percent fewer production and service wells (7). All other exploration, production, and transportation assumptions and facility locations as discussed in the base case of the proposed action virtually will be the same for this alternative. For further scenario information, please refer to Sections II.A. and IV.A.1.

Probability of One or More Spills Greater than or Equal or 1,000 Barrels Occurring: For this deferral alternative, there is a 23-percent probability of one or more spills ≥ 1,000 bbl occurring as compared to 27 percent for Alterative I (base case) (Table IV.A.2-2). The probability of one or more spills ≥ 1,000 bbl from (1) platforms is 10 percent, (2) pipelines is 11 percent, and (3) tankers is 5 percent as compared to 12, 13, and 6 percent, respectively, for Alternative I (base case) (Appendix B, Table B-1).

a. **Effects on Water Quality**: For Alternative IV, the activities associated with petroleum exploitation most likely to affect water quality in the CI/SS sale area are (1) the permitted discharges from exploration-drilling units and production platforms, (2) accidental oil spills, and (3) construction activities. Selecting the Wildlife Concentration Deferral Alternative would reduce the economically recoverable oil resources assumed for analysis from 200 MMbbl (Alternative I base case) to an assumed 160 MMbbl. The types of activities associated with exploiting the potential oil resources of this alternative are the same as for Alternative I (base case) but the level of activities are reduced (Table IV.A.1). The types and levels of activities include the number of wells drilled and quantities of muds and cuttings discharged, the number of production platforms and the types and quantities of discharges, the number of pipeline miles, and the estimated mean number of oil spills and the amount spilled (Tables II.A.2-1, II.A.2-2, IV.A.2-2, and IV.A.2-4). The characteristics of the discharges, spills, and activities and their potential effects on water quality are described in Section IV.B.1.a and summarized in this section.

The benefits of the deferral alternative are derived from (1) a reduced level of drilling and production activities associated with the exploration for and production of an assumed 160 MMbbl of oil and (2) the exclusion of exploration-drilling units and production platforms from locating in the deferred areas—about 12 percent of the Sale 149 Call area; these areas are shown in Figure II.D.1. Compared to Alternative I (base case), the reduced level of drilling and production activities would result in a decrease in the amount of material discharged into the waters of Cook Inlet. Based on information from Table IV.B.1.a-2, the discharges would be reduced by about (1) 3 to 14 percent for the drilling muds; (2) 14 percent for the cuttings; and (3) 20 percent for the produced waters. Excluding the drilling units and production platforms from the deferred areas eliminates the direct release of the permitted discharges into the waters of these areas.

The hydrodynamic processes in the Cook Inlet Planning Area suggest the water column generally is well mixed, and dilution would reduce the concentration of the substances in the discharges. Degradation processes also act to continuously reduce the concentrations of many substances deliberately or accidentally released into the environment.

Of the permitted discharges, drilling muds and cuttings and produced waters are the most significant discharges associated with offshore operations. The permitted discharges would add substances that may be foreign to or increase the concentration of constituents already present in the water column of CI/SS. This analysis will consider (1) the chronic criterion (for the protection of marine life) for SPM/turbidity to range from 100 to 1,000 mg/l (Sec. IV.B.1.a(1)(a)1)), (2) 15 μg/l to be the chronic criterion (for the protection of marine life) and 1,500 μg/l—a hundredfold higher level—to be the acute criterion for total hydrocarbons (Sec. IV.B.1.a(1)(b)2)a)), and (3) 10 μg/l to be the chronic criterion (for the protection of marine life) and 1,000 μg/l to be the acute criterion for TAH (Sec. IV.B.1.a(1)(b)2)a)). In general, the added substances may cause sublethal effects in some marine organisms if concentrations are greater than the chronic criteria and lethal effects if concentrations are greater than acute criteria.

Drilling of the 3 exploration, 4 delineation, and 41 production and service wells could result in the discharge of an estimated 5,800 to 17,690 tons (dry weight) of drilling-mud components and 26,040 tons (dry weight) of cuttings (Table IV.B.1.a-2). The concentrations of discharged drilling muds initially may range from about 1,000 to 2,000 g/l and are expected to be greater than the SPM turbidity chronic criteria, 100 to 1,000 mg/l, assumed for this analysis. However, within about 100 to 200 m of the discharge point, mixing in the water column would reduce the concentrations by a factor of 10,000 to 1,000,000; the diluted concentrations are estimated to range from 1 to 200 mg/l. The concentration of SPM in lower Cook Inlet and Shelikof Strait ranges from about 1 to 50 mg/l. Most of the solids in the discharges settle rapidly to the seafloor, where bottom currents disperse the finer particles. The drilling discharges are expected to take place over a 5- or 6-year period—most of the discharges would occur in the last 3 years and be associated with the drilling of the production and service wells.

Produced waters constitute the largest source of substances discharged into the marine environment, and their discharge is an issue of significant concern because of the types and amounts of naturally occurring substances they may carry and the manmade substances that may be added. The amount of produced water that would be discharged as a consequence of producing an assumed 160 MMbbl of oil in 19 years is estimated to range from about 14 to 118 MMbbl, or more (Table IV.B.1.a-2). The toxicity of produced waters mainly is caused by hydrocarbons that include nonvolatile hydrocarbons (USEPA oil and grease) and aromatic hydrocarbons. The discharges associated with production activities are expected to last for the life of the field(s), at least 19 years, and the rates increase with time. The concentrations of nonvolatile hydrocarbons and TAH in the produced waters are estimated to range from 19 to 36 mg/l (19,000-36,000 μg/l) and 8 to 13 mg/l (8,000-13,000 μg/l), respectively.

The dilution rates for the produced waters are estimated to range from about 1,000:1 to 1,000,000 within several hundred meters of the discharge site. If dilutions are based on a rate of 1,000:1, the concentrations of nonvolatile hydrocarbons (oil and grease) within several hundred meters of the platform might range from 19 to 36 μg/l and the concentrations of TAH might range from 8 to 13 μg/l. These concentrations are well below the acute criteria of 1,500 μg/l for the nonvolatile hydrocarbons and 1,000 μg/l for the TAH that were assumed for this analysis but, in general, slightly greater than the chronic criteria of 15 μg/l for the nonvolatile hydrocarbons and 10 μg/l for the TAH. If dilutions rates are about 10,000:1, the concentrations of non- volatile hydrocarbons might range from about 2 to about 4 μg/l, and the concentrations of TAH might be about 1 μg/l; these concentrations are less than the respective chronic criteria assumed for analysis. When discharged, the toxicity of the produced waters is expected to range from slightly toxic to practically nontoxic and will decrease with continued mixing in the water column.

The characteristics of the other constituents of the produced waters or other production-related discharges are expected to be within the EPA criterion and/or be diluted in the water column within an area of <2 km^2 to background concentrations or levels that would not cause sublethal to lethal effects in marine organisms.

The potential effects in any of the areas where there are permitted discharges would last for about (1) 2 to 3 months for each exploration well drilled and (2) 22 years for development and production activities. Future procedures and technologies of treating and handling drilling muds and cuttings and produced waters may reduce or eliminate the amounts discharged.

Accidental oil spills introduce into the water column a variety of hydrocarbon compounds whose concentrations may cause sublethal to lethal effects in marine organisms. Hydrodynamic and meteorological forces increase the areal extent of the spill and physical, chemical, and microbiological forces degrade the oil and reduce its concentration and toxicity.

The number of small (< 1,000-bbl) accidental oil spills that might occur if oil is produced is estimated to be 39; the total volume of oil spilled is estimated to be 505 bbl (37 spills that average 5 bbl in size and two 160-bbl spills) (Tables IV.A.2.4b and 4c). At the end of 3 days assuming no cleanup, the oil from a small spill may be dispersed in a 1- to 10-km^2 area in concentrations of about 20 to 61 μg/l. The concentration of the dispersed oil 10 days after a spill is estimated to be between 3 and 14 μg/l in an area of about 9 to 48 km^2 and, after 30 days, < 1 to about 1 μg/l in an area of 34 to 199 km^2. During the 3- to 30-day interval following a small spill, the concentration of oil in the water column is not expected to exceed the total hydrocarbon acute criterion, 1,500 μg/l, assumed for this analysis; however, the concentration of spilled oil is expected to exceed the assumed total hydrocarbon chronic criterion, 15 μg/l, for several days to weeks.

There is a 23-percent chance that one or more oil spills ≥ 1,000 would occur but, if it did, the size of the spill is estimated to be about 50,000 bbl (Table IV.A.2-2). For a summer spill, the concentration of total hydrocarbons in the water column from a large spill is not expected to exceed the chronic criterion (1,500 μg/l), at least after 3 days, but may exceed the acute criterion (15 μg/l) for more than 30 days. In the summer at the end of 3 days assuming no cleanup, the oil from a large spill may be dispersed in a 190-km^2 area in concentrations of about 711 μg/l. The concentration of the dispersed oil 10 days after a spill is estimated to be about 163 μg/l in an area of about 912 km^2 and, after 30 days, 21 $\mu\mu$g/l in an area of about 3,715 km^2.

If the spill occurred in the winter, the size of the affected areas after the 3-, 10-, and 30-day time intervals would be less than for a summer spill, but the concentration of oil in the water column would be greater. The oil in the water column is not expected to exceed the total hydrocarbon acute criterion (1,500 μg/l) during the (1) 3- to 30-day interval following a large spill under open-water conditions and (2) 10- to 30-day interval after a large spill in broken ice. During the 3- to 10-day interval following a large spill, the oil in the water column is expected to exceed the total hydrocarbon acute criterion (1,500 μg/l) under broken-ice conditions. The concentration of total hydrocarbons in the water column during the winter may exceed the acute criterion (15 μg/l for > 30 days.

Construction activities would increase the turbidity in the water column along segments of a 120-mi corridor for about 2 to 4 months, but there would be no degradation of the overall water quality.

Summary: The discharge of drilling muds and cuttings and other discharges associated with exploration drilling are not expected to have any effect on the overall quality of the Cook Inlet water. Within a distance of between 100 and 200 m from the discharge point, the turbidity caused by SPM in the discharged muds and cuttings is expected to be diluted to levels that are less than the chronic criteria (100-1,000 mg/l) and within the range associated with the variability of naturally occurring SPM concentrations. Mixing in the water column would reduce the toxicity of the drilling muds which, in general, are practically nontoxic to levels that would not be harmful to organisms in the water column. In general, the amounts of additives in the other discharges are expected to be relatively small (from 1 to 100 or 200 g/month) and diluted with seawater several hundred to several thousand time before being discharged into the receiving waters.

The discharge of produced waters is not expected to degrade the quality of Cook Inlet water. Mixing and weathering processes will continuously reduce the concentrations of the hydrocarbons in the produced waters. Mixing is expected to reduce the concentrations of the nonvolatile hydrocarbons and TAH's to concentrations that are less than the chronic criteria of 15 μg/l and 10 μg/l, respectively. The pH of the produced waters is expected to be within the range specified by the USEPA. The salinities of the produced waters would be within the range of salinities that are found in Cook Inlet. The discharge of metals, as indicated by zinc, generally would be less than the amounts streams and rivers discharge into Cook Inlet. Mixing in the water column would reduce the toxicities of the produced waters which, in general, may range from slightly toxic to practically nontoxic prior to discharge.

Small oil spills, as represented in this analysis by 5- and 160-bbl spills, are not expected to have any degradational effects on the overall water quality of Cook Inlet. The small spills would degrade the water quality for a relatively short period of time, perhaps up to about 10 days, in areas of less than about 50 km^2. As noted in Section III.A.5.c(4)(e), the concentration of any of the various types of hydrocarbons in the water column generally are quite low or below detection limits.

A large oil spill (≥ 1,000 bbl), as represented in this analysis by a spill of 50,000 bbl of crude oil, would degrade the quality of Cook Inlet water for a period of about a month or longer in an area that might extend over several thousand square kilometers; the probability of one or more spills ≥ 1,000 bbl occurring is estimated to be 23 percent. If the spill occurs within a relatively short period of time, as measured in hours, the hydrocarbon concentration in the water column generally is expected to be less than the acute criterion (1,500 μg/l) within several days. However, the hydrocarbon concentration may remain greater than the chronic criterion (15 μg/l) for a month, or more.

Conclusion: The permitted, routine discharges associated with oil and gas development and small (< 1,000 bbl) oil spills are not expected to cause any measurable overall degradation of Cook Inlet water quality; routine discharges would be prohibited in the deferred areas (about 12% of the Sale 149 area) and the amounts discharged reduced (about 3-20%). Water quality would be reduced from good (unpolluted) to polluted by the presence of hydrocarbons from one or more large (≥ 1,000 bbl) oil spills, which have a relatively low probability (23%) of occurring. Contamination (the presence of hydrocarbons in amounts > 15 μg/l) would be temporary (last for a month or more) and affect an area of several thousand square kilometers.

b. Effects on Lower Trophic-Level Organisms: Routine activities associated with the Wildlife Concentration Deferral Alternative (Alternative IV) that may affect lower trophic-level organisms include seismic surveys, drilling discharges, and construction. Accidental activities include exposure to petroleum-based hydrocarbons from an oil spill. The effects of these routine and accidental activities on lower trophic-level organisms are discussed in the base case (Sec. IV.B.1.b) and are summarized below. The following analysis for Alternative IV focuses on the differences in the amount of activity (the only variable) estimated for Alternative IV, as compared to that of the base case. It then estimates the resulting effect of this difference on lower trophic-level organisms for Alternative IV.

Alternative IV would delete 52 partial and whole blocks, or about 12 percent of the sale area discussed in the base case. This would eliminate any OCS activity in the deferral areas and would eliminate them as areas where a platform oil spill could originate. However, platforms outside the deferral areas still would be a potential oil-spill source that could affect the deferral areas. More importantly, the probability of one or more oil spills occurring from an oil tanker or pipeline (the primary oil-spill sources) for the deferral areas would be nearly the same (a 1-2% difference) as the base case (Appendix B, Table B-1). Hence, in terms of an oil spill, the only difference between Alternative IV and the base case is the extra time it would take for a platform (now outside of the deferral areas for Alternative IV) spill to reach deferral-area shorelines. This extra time would reduce the amount of toxic hydrocarbons reaching deferral-area shorelines. However, the surface oil (the most damaging aspect of spilled oil) could still reach these shorelines in 10 days. Further, because of the speed of water movement in Cook Inlet/Shelikof Strait and the relatively small size of the deferral areas in Alternative IV, the reduction in toxicity is expected to be relatively small. For these reasons, and because there would be only a minor change from the base case in the probability of an oil spill from the primary oil-spill contributors (tankers and pipelines), the effects of Alternative IV on lower trophic-level organisms are expected to be essentially the same as discussed for the base case and are summarized below.

Seismic surveys are expected to have little to no effect on lower trophic-level organisms. Drilling discharges are estimated to affect < 1 percent of the benthic organisms in the sale area and none of its plankton. Recovery is expected to occur within 1 year. Construction activities are expected to have little or no effect on plankton communities. Less than 1 percent of the immobile benthic organisms would be affected. Immobile benthic communities affected by pipeline construction are expected to recover in < 3 years. The effects of petroleum-based hydrocarbons on phytoplankton, zooplankton, and benthic organisms range from sublethal to lethal. Where flushing times are longer and water circulation is reduced (e.g., bays, estuaries, and mudflats), adverse effects are expected to be greater, and the recovery of the affected communities is expected to take longer. Large-scale effects on plankton due to petroleum-based hydrocarbons have not been reported. Assuming that a large number of phytoplankton were contacted by an oil spill, the rapid replacement of cells from adjacent waters and their rapid regeneration time (9-12 hours) would preclude any major effect on phytoplankton communities. Observations in oiled environments have shown that zooplankton communities experienced short-lived effects due to oil. Affected communities appear to rapidly recover from such effects because of their wide distribution, large numbers, rapid rate of regeneration, and high fecundity. Large-scale effects on marine plants and invertebrates due to petroleum-based hydrocarbons have been reported. The sublethal effects of oil on marine plants include reduced growth and photosynthetic and reproductive activity. The sublethal effects of oil on marine invertebrates include adverse effects on reproduction, recruitment, physiology, growth, development, and behavior (feeding, mating, and habitat selection).

Based on the assumptions discussed in the text (see Sec. IV.B.1.b), the assumed oil spill for Alternative IV is estimated to have sublethal and lethal effects on 1 to 3 percent of the phytoplankton and zooplankton populations in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. The total percentage of plankton affected could increase to 5 percent if many embayments were contacted by the spill. Recovery within the affected embayments is expected to take 1 to 2 weeks. Marine plants and invertebrates in subtidal areas are not likely to be contacted by an oil spill, but marine plants and invertebrates in intertidal and shallow subtidal areas are likely to be contacted by an oil spill. Based on the assumptions discussed in the text (see Sec. IV.B.1.b), the assumed oil spill for Alternative IV is estimated to have lethal and sublethal effects on about 20 to 30 percent of the intertidal and shallow subtidal marine plants and invertebrates in the sale area. Recovery of these communities is expected to take 2 to 3 years in high-energy habitats and up to 7 years in lower energy habitats. Small oil spills (estimated total of 505 bbl) may adversely affect individual lower trophic-level organisms in small areas immediately around the spills. However, they are not expected to have perceptible effects on lower trophic-level organisms at the population level.

Conclusion: Alternative IV is expected to have essentially the same effect as that of the base case. The assumed oil spill associated with Alternative IV is estimated to have lethal and sublethal effects on 1 to 5 percent of the plankton in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 2 weeks for zooplankton. It also is estimated to have lethal and sublethal effects on about 20 to 30 percent of the intertidal and shallow subtidal marine invertebrates in the sale area. Recovery of these communities is expected to take 2 to 3 years in high-energy habitats and up to 7 years in lower energy habitats. Less than 5 percent of the subtidal benthic populations in the sale area are expected to be affected. All of the above effects are based on the assumptions discussed in the text (e.g., the 50,000-bbl-oil spill occurs, and land segments having a probability of occurrence and contact ≥1 percent are contacted).

c. Effects on Fisheries Resources: This alternative removes lease blocks from the sale area that are adjacent to important wildlife-concentration areas, creating buffer zones. This reduces the probability of contact from a spill to the important wildlife areas from pipelines or platforms in these zones and reduces the amount of noise and disturbance in and around the wildlife areas. The effect of this deferral alternative on the most sensitive fisheries-resource areas in the sale area that could be affected under the base case will be examined using 30-day conditional probabilities for the summer season. Effects on fisheries resources due to (1) oil spills and oil pollution, (2) noise and disturbance, and (3) habitat loss and/or alteration have been analyzed and appear in full under the base case (Sec. IV.B 1.c).

The effects of an oil spill were reviewed for fisheries resources in the sale area. Sale-specific oil-spill effects on fisheries resources have been estimated using combined probabilities generated from the OSRA model. Effects on fisheries derived from the EVOS studies were used to estimate potentially lethal effects of an oil spill on fisheries resources. Sale-specific oil-spill effects are not expected to directly affect returning adult salmon or steelhead. Oiled intertidal areas could cause an increased mortality to pink salmon eggs in the affected areas, but the increased egg mortality is not expected to cause reduced adult survival. An increased level of developmental malformations and increased egg-larval mortality could cause reduced survival to adulthood in herring populations affected by an oil spill. These effects are expected to be limited to the year-class spawned during the spill year and be masked to some extent by the contribution of other year-classes to the herring population. Eggs and larvae of some semidemersal and demersal fishes may suffer increased mortality from oil contact. Also, some demersal fish populations could be exposed to oil in the event of a spill, and a few individuals could be killed. Based on experience of the EVOS, however, it is unlikely there would be any population-level effects to demersal fishes.

Indirect effects such as ingesting oil from contaminated food could cause slower growth of pink salmon juveniles due to the metabolic cost of depurating the hydrocarbon burden. This may have an incremental reduction in survival to adulthood but is not expected to have population-level effects.

Fisheries resources could be disturbed and displaced from the immediate vicinity of drilling discharges, within a radius probably not to exceed 100 m. These effects on demersal fishes very likely would be limited to only the short time periods of the discharge. Offshore construction also could temporarily disturb and/or displace fisheries resources. Any disturbance or displacement should be short term (hours to days), limited to only the time of construction and shortly thereafter. Though seismic surveys may damage eggs and larvae of some fishes, this injury is limited to within a meter or two from the airgun-discharge ports. Thus, seismic surveys probably would have no appreciable adverse effects on fish populations.

The buffer zones created by the wildlife concentration deferral would reduce some risk to fisheries resources in lower Cook Inlet in the vicinity of Tuxedni Bay (ERA 1), the Barren Islands (ERA 6), and Cape Douglas (ERA 7). The chance of spill contact due to production is reduced by half around Tuxedni Bay, where there is an estimated chance of contact as high as 95 percent (Appendix B, Fig. B-1). Risk is reduced to the Barren Islands in some areas where the chance of contact is between 5 and 50 percent and to Cape Douglas, where the chance of contact is between 25 and 75 percent (Appendix B, Figs. B-6 and B-7). Most of the reduced risk is in environmental resource areas with a chance of contact between 5 and 25 percent. Some increased protection is realized to outmigrating salmonid smolts along western Cook Inlet in the vicinity of Tuxedni Bay and to halibut and other demersal fishes near the Barren Islands and Cape Douglas.

In summary, the estimated spill effects under the wildlife concentration deferral essentially would be unchanged from the base case. The short-term, local effects of noise, disturbance, and habitat alteration would be lessened for species in the deferral area. These include salmonids and demersal fishes, particularly halibut.

Conclusion: Relative to the base case, the estimated spill effects would be unchanged, with potential for increased mortality in pink salmon eggs and an increased level of developmental malformations and increased egg-larval mortality in herring. Eggs and larvae of some demersal and semidemersal fish also could suffer some increased mortality. Potential habitat alteration and noise and disturbance effects to fisheries resources due to exploration and production in these buffer areas also were eliminated by the deferral alternative. The various effects to fisheries resources taken altogether are not expected to cause population-level changes.

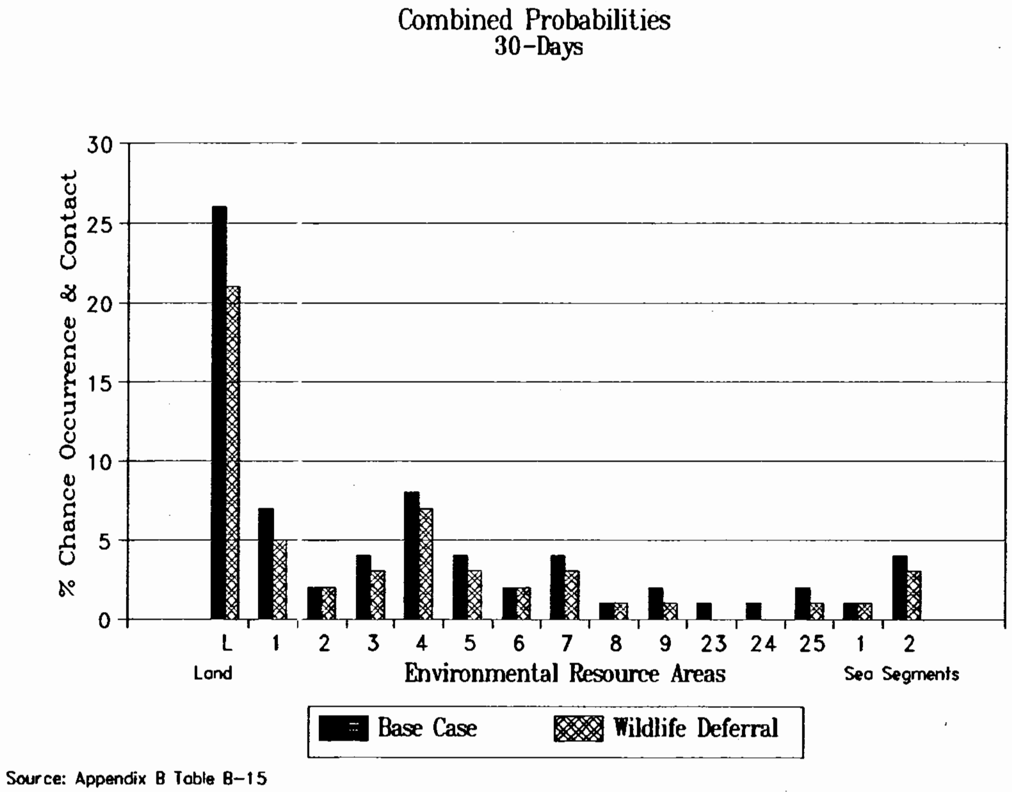
d. Effects on Marine and Coastal Birds: Alternative IV would remove approximately 52 blocks (12.21% of the sale area) from the proposed lease sale, providing buffer zones for two major marine and coastal bird habitat and concentration areas. These buffer zones are approximately 15- to 20-mi wide and include (1) an area on the western side of the Barren Islands, a major seabird colony complex and (2) an area on the eastern side of Chisik/Duck Islands containing important Cook Inlet seabird colony locations.

These buffer zones surrounding major wildlife-concentration areas could provide some protection from oil spills for these habitats by eliminating potential platform-spill locations from the immediate vicinity. Potential platform oil-spill sites within about 10 to 15 mi of the Barren Islands that have an estimated conditional probability ≥25 percent of contacting the Barren Islands (ERA 6) seabird-forage-concentration area within 30 days during the summer season are eliminated (Appendix B, Fig. B-6). However, a potential pipeline or tanker oil spill associated with this alternative is estimated to contact the Barren Islands (see Figs. IV.B.1.d-3, 4, and 5). A potential pipeline or tanker spill associated with the proposal still would pose the same chance of contacting Chisik/Duck (ERA 1) and Barren Islands, and other marine and coastal bird habitats and concentration areas, as described under the proposal.

The chance of one or more oil spills ≥1,000 bbl occurring in this alternative decreases from 27 percent under the base case to 23 percent. A comparison of Alternative I and Alternative IV combined probabilities (expressed as percent chance) of one or more spills ≥1,000 bbl occurring and contacting environmental resource areas important habitats for marine and coastal birds is shown in Figure IV.B.4.d-1. Alternative IV reduces the combined probabilities of one or more spills ≥1,000 bbl occurring and contacting 11 of the 15 environmental resource areas (including contact to land in general) estimated under Alternative I. The highest reduction in the chance of oil-spill occurrence and contact are to the Tuxedni Bay (ERA 1, from 7-5%) and to land in general (from 26-21%) (Appendix B, Tables B-14 and B-15). The reductions in the combined probabilities of one or more spills ≥1,000 bbl occurring and contacting other environmental resource areas reflect the reduction in volume of oil assumed to be present in the deferral area.

Thus, some limited reduction of oil-spill risk to seabirds, sea ducks, and shorebirds and their habitats in the Tuxedni Bay (Chisik-Duck Islands) area and some reduction in potential platform-spill risks to the Barren Islands' seabird colonies are expected under this alternative. However, the overall effects of oil spills, noise and disturbance, and habitat alteration on other marine and coastal birds are expected to be the same as the base case, because the transportation scenario and levels of exploration and development activities are assumed to be the same for both alternatives.

Conclusion: The overall effects of potential oil spills (the loss of perhaps 100,000 birds), noise and disturbance, and onshore-habitat alteration (10 acres) on marine and coastal birds persisting for more than one generation



Source: Appendix B Table B-15

Figure IV.B.4.d-1. Combined Probabilities (expressed as percent chance) Of One or More Spills ≥ 1,000 Barrels Occurring and Contacting Certain Environmental Resource Areas Within 30 Days Under the Base Case and Under Alternative IV Over the Assumed Production Life of the Sale 149 Area.

(probably less than three generations) are expected to be the same as described for the base case (loss of several thousand birds with recovery taking <3 generations or <15 years). This deferral could provide localized reduction in potential platform oil-spill effects to seabirds nesting in Tuxedni Bay (Chisik/Duck Islands) and, to a lesser extent, the Barren Islands and other marine and coastal bird habitats areas.

e. Effects on Nonendangered Marine Mammals (Pinnipeds, Cetaceans, and the Sea Otter): This alternative removes lease blocks from the sale area that are adjacent to important wildlife-concentration areas, creating buffer zones. This reduces the probability of contact from a spill to the important wildlife areas from pipelines or platforms in these zones and reduces the amount of noise and disturbance in and around the wildlife areas. The effect of this deferral alternative is examined using 30-day conditional probabilities for the summer season on the most-sensitive marine mammal resource areas in the sale area that could be affected under the base case. Effects on marine mammals due to (1) oil spills and oil pollution, (2) noise and disturbance, and (3) habitat loss and/or alteration were analyzed and appear in full under the base case (Sec. IV.B.1.e).

Sale-specific oil-spill effects on marine mammal resources were estimated using combined probabilities, conditional risk contours, and conditional probabilities for transportation segments generated from the OSRA model. Mortality rates derived from the EVOS and adjusted by the SF were used to estimate potentially lethal effects of an oil spill on each species. Sale-specific oil-spill effects were estimated to result in mortality of <10 fur seals and killer whales, respectively; approximately 43 beluga whales; approximately 60 harbor seals; and between 75 to 100 sea otters. Recovery to prespill numbers was estimated to occur in about 1 to 2 years, with the exception of beluga whales, where recovery may require up to 7 years.

Effects to marine mammals due to noise and disturbance also were reviewed and estimated. The loudest noise source created by industry activity was identified as seismic noise. Sounds generated by seismic surveys probably would not affect harbor and fur seal and sea otter activities. Effects on the minke whale have not been studied but likely would be similar to effects on other baleen whales, which generally are tolerant of seismic pulses. Subtle behavioral changes may occur on occasion at low-sound levels, with stronger avoidance reactions when sound levels reach 160 to 170 dB, or higher. Toothed-whale hearing appears poor at frequencies lower than 1 kHz, where most industrial sounds and seismic pulses are produced, so they probably would be unaffected.

Aircraft overflights can be another potential source of disturbance. Pinniped response to low-altitude aircraft can result in stampede or flight into the water. This may increase pup mortality during the pupping season. Both baleen and toothed whales usually respond to low overflights by diving. Reactions of pinnipeds and cetaceans vary by aircraft type, altitude of flight, and circumstances of the animals. These disturbance reactions usually are short term, with seals reoccupying haulouts and whales continuing their activities usually within a matter of hours.

The effects of habitat alteration/degradation also were examined. These would be limited to temporary disturbance to some sea otters and harbor seals in the nearshore environment associated with construction of pipeline and transport facilities. This disturbance likely would be relatively short term and very localized and should not affect survival.

The buffer zones created by the wildlife concentration deferral are effective in reducing risk to environmental resources in lower Cook Inlet in the vicinity of Tuxedni Bay (ERA 1), the Barren Islands (ERA 6), and Cape Douglas (ERA 7). The chance of spill contact due to production is reduced by half around Tuxedni Bay, where there is an estimated chance of contact to these resources as high as 95 percent (Appendix B, Fig. B-1). Risk is reduced to the Barren Islands in some areas where chance of contact is between 5 and 50 per- cent and to Cape Douglas, where chance of contact is between 25 and 75 percent (Appendix B, Figs. B-6 and B-7). Most of the reduced risk is in environmental resource areas with a chance of contact between 5 and 25 percent. These buffers primarily reduce some risk to sea otters, harbor seals, and foraging fur seals in the Barren Islands area and harbor seals and beluga whales in the Tuxedni Bay area.

In summary, the estimated spill effects under the wildlife concentration deferral would be unchanged from the base case, with a potential mortality of <10 fur seals and killer whales, respectively; approximately 43 beluga whales; approximately 60 harbor seals; and between 75 to 100 sea otters. Recovery to prespill numbers is estimated to occur in about 1 to 2 years, with the exception of beluga whales, where recovery may require up to 7 years. The short-term, local effects of noise, disturbance, and habitat alteration would be lessened for the nearshore species in the deferral area. These include sea otters, harbor seals, foraging fur seals, and some nonendangered cetaceans.

Conclusion: Relative to the base case, the estimated spill effects under this deferral alternative would be unchanged, with a potential mortality of < 10 fur seals and killer whales, respectively; approximately 43 beluga whales; approximately 60 harbor seals; and between 75 to 100 sea otters. Recovery to prespill numbers is estimated to occur in about 1 to 2 years, with the exception of beluga whales, where recovery may require up to 7 years. Potential habitat alteration and noise and disturbance effects to these marine mammals due to exploration and production in these buffer areas also were eliminated by the deferral alternative.

f. **Effects on Endangered and Threatened Species:** Alternative IV (Wildlife Concentration Deferral) would remove lease blocks from the proposed lease sale area east of Tuxedni Bay/Chisik Island and west of the Barren Islands, providing buffers that extend between 3 and 8 to 17 mi offshore. However, only those deferred lease blocks in the southeastern sale area lie within the zone of probable seasonal occurrence of endangered whale species and areas potentially used by foraging or rafting Steller sea lions from the major Barren Islands rookery and peripheral haulouts. Nevertheless, this alternative removes approximately percent of the limited southern sale area within which, under Alternative I (proposed action, Sec. IV.B.1.f), a small proportion of these species' populations potentially could be exposed to routine exploration and development/production activities.

For these populations, the most likely sources of potentially adverse effects associated with routine activities are disturbance (primarily aircraft and vessel traffic, drilling operations, seismic surveys) and release of drilling muds and cuttings. The buffer created by removing lease blocks from the sale area would be expected to reduce effects of activity somewhat in these areas as a result of the greater distance between potential platform sites and wildlife concentrations. However, as discussed for Alternative I, potential effects from routine activities already are likely to be minimal because of the expectation that travel routes of few whales or sea lions will intersect those of vessels or aircraft, or approach a platform, and that any interaction effects (e.g., travel direction change, area avoidance) will last for less than an hour. Likewise, exposure of whales or sea lions, or their prey species, to any materials (e.g., muds and cuttings) released into the environment is expected to have minimal effects due to rapid dispersal of such materials to nontoxic concentrations in this oceanographically dynamic area.

Buffers created by the deferred areas may provide adjacent nearshore and coastal habitats some protection from an oil spill by eliminating potential platform-spill locations adjacent to these sites. This would increase the time oil would be subject to weathering and cleanup operations before contacting such habitats. In particular, potential platform sites near the Barren Islands (ERA 6), where the conditional probability (expressed as percent chance) of spilled-oil contact is 25 percent or more, would be eliminated by this alternative (Appendix B, Fig. B-6). However, only a minor decrease in risk to whales and sea lions from Alternative I is expected in this area because the probability of one or more spills decreases only slightly (from 27% to 23%, Table IV.A.2-2). South of the proposed sale area, the potential for occurrence and contact of one or more ≥1,000 bbl spills to Puale Bay, for example (ERA 12), where effects on contacted sea lions gathered there would be as described under Alternative I (losses requiring at least 1 generation for recovery), remains essentially unchanged (<0.5%, Table B-14, B-15); in northern Shelikof Strait areas (ERA's 7-11), the chance of contact declines slightly (0-1%, to values ranging from <0.5-4%) from Alternative I with this deferral. The combined probability (expressed as percent chance) of one or more ≥1,000 bbl spills occurring and contacting areas (ERA's 3, 5, 7-12) occupied by wintering Steller's eiders declines from ≤4 percent (Kachemak Bay) ≤3 percent.

Deferral of blocks from the southeastern sale area may provide some limited relief from disturbance and possible contact with drilling muds and cuttings, and any oil spilled, for the small numbers of endangered whales and Steller sea lions that transit or occupy the southeastern and southern portions of the proposed sale area by removing potential platform sites and associated support activities farther from the Barren Islands, migration routes, and foraging areas. Risk to Steller's eiders wintering along the Alaska Peninsula to Kodiak Island and Kachemak Bay from an oil spill also is somewhat reduced. Thus, potential effects from this alternative are expected to be reduced to a limited extent from those discussed for Alternative I, which include: (1) Exposure of ≤1 percent of the North Pacific fin whale and 5 percent of humpback whale populations occurring in this area to disturbance, with individuals being affected for an hour or less per incident. (2) Similarly small numbers of whales exposed to an oil spill, with any effects sublethal and short term. (3) A tanker spill outside entrances to Cook Inlet/Shelikof Strait contacting larger numbers of whales east of Kodiak Island, but without the occurrence of any mortality. (4) Less than 2 percent of the central Gulf of Alaska Steller sea lion population (5% of the potentially affected area population) exposed to potentially disturbing activities, with no rookeries or haulouts likely to be disturbed. (5) An oil spill potentially contacting up to several hundred sea lions, but adult mortality not exceeding a few tens of individuals. The survivorship of pups and juveniles would be more severely affected. (6) Overall sea lion mortality resulting from an oil spill is expected to be < 100 individuals, requiring a recovery period of at least one generation. (7) No endangered or threatened bird populations are expected to be affected by exploration or development/production activities. (8) Wintering Steller's eiders are not likely to be affected by exploration activities but may experience oil-spill losses requiring two generations for recovery.

In summary, this alternative is expected to provide limited local reduction in disturbance and oil-spill effects by eliminating potential platform sources of noise and oil spills from the vicinity of Steller sea lion intensive-use sites, and areas that may be seasonally occupied by small numbers of endangered whales near the Barren Islands.

<u>Conclusion</u>: The overall effect of this alternative is expected to be essentially the same as determined for proposed Alternative I (effects on whales nonlethal, sea lions requiring at least 1 generation for recovery, Steller's eider requiring 2 generations for recovery), because the major sources of an oil spill remain unchanged and effects of disturbance already are minimal.

g. Effects on Terrestrial Mammals: Alternative IV would remove approximately 52 blocks (12.21% of the sale area) from the proposed sale, providing buffer zones for two coastal-wildlife habitats and concentration areas.

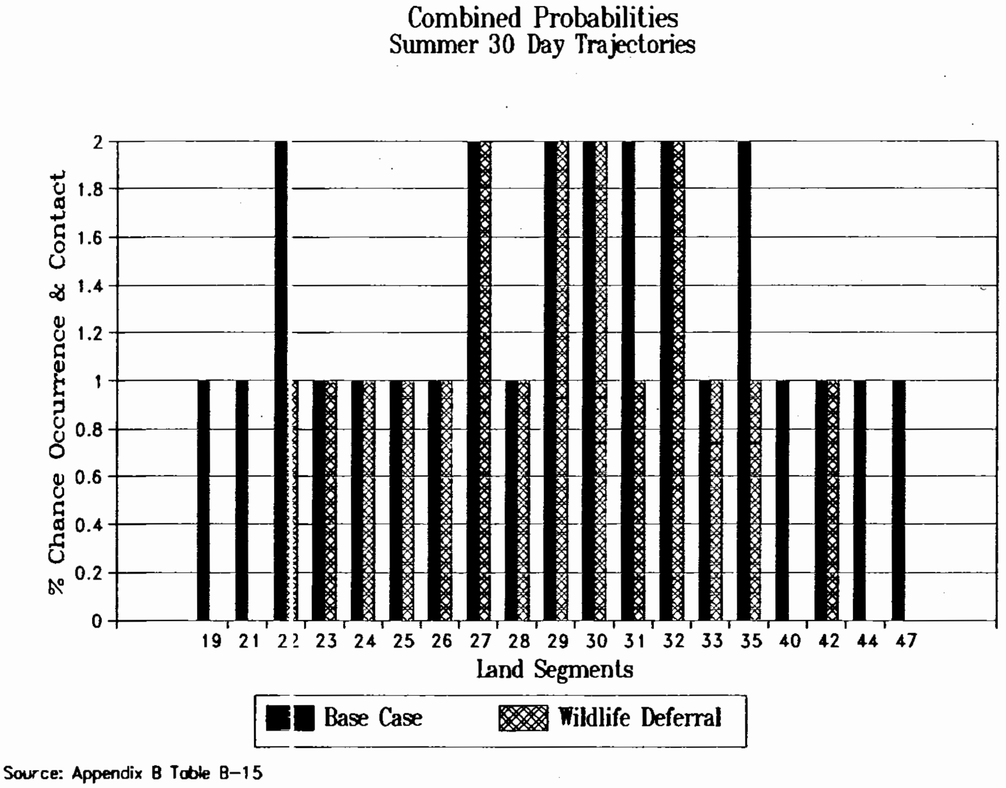
These buffer zones are approximately 15- to 20-mi wide and include (1) an area on the western side of the Barren Islands and (2) Tuxedni Bay area containing brown bear spring-summer habitats along the shore. These buffer zones surrounding important wildlife-habitat areas could provide some protection from oil spills for these habitats by eliminating potential platform-spill locations from the immediate vicinity. The probability (expressed as percent chance) of one or more oil spills ≥1,000 bbl occurring decreases from 27 percent under the base case to 23 percent under Alternative IV (Table IV.A.2-2).

A comparison of Alternative I and Alternative IV combined probabilities (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting land segments representing coastal habitats of terrestrial mammals is shown in Figure IV.B.4.g-1. Alternative IV reduces the combined probabilities (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting for 9 of the 19 land segments estimated under Alternative I. Some reduction in the combined probability is shown for the following areas: The Alaska Peninsula from Hallo Bay north to include the Cape Douglas area (LS's 19, 21, and 22), Iliamna Bay (LS 28), The forelands north of Chinitna Bay to Tuxedni Bay (LS 31), Kalgin Island (LS 35), the Nikishka area on the Kenai Peninsula (LS 40), and Kachemak Bay and western Barren Islands (LS's 44 and 47). The reduction in the combined probability to terrestrial mammal habitats in the Forelands north of Chinitna Bay area (LS 31) and to the western Barren Islands (LS 47) reflects the buffer zone deferred from leasing under this alternative. However, the reductions in combined probability of other shoreline habitats generally reflect the reduction in volume of oil expected to be produced under this alternative compared to the base case.

The Tuxedni Bay (ERA 1) deferred area would eliminate potential platform-spill sites with >50-percent estimated chances of contacting this habitat area within 30 days during the summer (Appendix B, Fig. B-1), but potential platform-spill sites farther away from Tuxedni Bay still would pose a >25 and <50-percent estimated chance of contacting the Tuxedni Bay shoreline within 30 days during the summer (Appendix B, Fig. B-1). The deferred area on the western side of the Barren Islands would provide little reduction in estimated conditional probabilities of spill contact from potential platform sites in the sale area. The primary spill-contact risks to these habitats would come from a potential pipeline or tanker spill associated with the transportation scenario, which is the same for this alternative as it is for the proposal.

Some limited reduction of oil-spill risk to brown bears, river otters, and other terrestrial mammals and their habitats along the shoreline of Tuxedni Bay, the forelands north of Chinitna Bay, Alaska Peninsula, and Kachemak Bay is expected under this alternative. However, the chance of contact from a potential oil spill along the pipeline and tanker route in Cook Inlet would remain unchanged, and other coastal (shoreline) habitats of terrestrial mammals in lower Cook Inlet are expected to be contacted by the assumed 50,000-bbl-oil spill. Thus, the potential overall oil-spill effect on terrestrial mammals is expected to remain about the same as described under the proposal.

Noise and disturbance (temporary displacement within 1 mi of air and vessel traffic) and habitat-alteration (about 50 acres) effects on terrestrial mammals are expected to be the same as described under the Alternative I base case,



Source: Appendix B Table B-15

Figure IV.B.4.g-1. Combined Probabilities (expressed as percent chance) of One or More Oil Spills ≥1,000 bbl Occurring and Contacting Certain Land Segments Under the Base Case and Under Alternative IV, the Wildlife Deferral Over the Assumed Production Life of the Sale 149 Area.

because both alternatives are assumed to use the same transportation scenario with the same amount and location of air and vessel traffic and the same onshore-support facilities to be constructed.

Conclusion: The overall effect on terrestrial mammals (loss of <50 river otters, <100 deer, and <10 bears) is expected to be about the same as under the proposal (local recovery to take >1 to perhaps 3 years for river otters and perhaps for brown bears and 1 year for deer). Potential oil-spill effects on terrestrial mammals could be reduced locally in the Tuxedni and Chinitna Bays area, Alaska Peninsula, and Kachemak Bay from a potential platform spill; but a potential pipeline or tanker spill still would pose some chance of contact to these species at these habitats and also would affect bears, river otters, and other terrestrial mammals at other coastal habitats.

h. Effects on the Economy: Increased employment is the most significant economic effect generated by Alternative IV, the Wildlife Concentration Deferral Alternative. Employees would work on the construction, operation, and servicing of facilities associated with the sale. These facilities are described in the estimated and assumed scenario, Table II.D.1, and are 3 exploration wells, 4 delineation wells, and 3 production platforms in 1998; 48 production/service oil wells; 1 shore base constructed; and 120 mi of offshore pipeline.

For Alternative IV, direct OCS resident employment on the western side of the Kenai Peninsula would start with 240 in 1997; rise to 307 in 1998, to 697 in 1999, to 1,007 in 2000, and 1,284 in 2001; drop to 1,047 in 2002; and drop to 784 in 2003. The employment level varies from 734 to 756 from the year 2004 through 2020. Indirect resident employment is estimated to be 12.6 percent of direct OCS-resident employment and would peak at 162 for the year 2001. (See Appendix G for a description of the methodology for employment and population forecasts. Also see Sec. IV.B.1.h, Economy, for assumptions and general analytic method used for this alternative.)

Resident employment on the western side of the Kenai Peninsula is estimated to be 15,986 for 1995 and is projected to rise 0.9 percent annually without the sale. Between the years 1997 and 2003, direct OCS employment and indirect employment would increase and decrease, resulting in changes of between 0 and 3 percent each year.

The OCS activity could generate effects on other facets of the economy including income, prices, and taxes. The OCS workers likely would earn relatively high wages compared to the average income on the western part of the Kenai Peninsula. Even assuming the income of the OCS workers were twice as high as the average for the western Kenai Peninsula, the effect on the average income would be a <3-percent change for <5 years. This is because the largest rise for 1 year in direct OCS employment is 390 workers in 1999 compared to resident employment of 16,422 in 1998.

The <3-percent rise in average income for <5 years is the basic economic driving force of price inflation. The maximum rise in resident employment of 3 percent for 1 year, even assuming that the average income is twice the average for the KPB for 697 direct OCS workers, translates to price inflation of <3 percent for <5 years for the western Kenai Peninsula. Because of the relatively short time—6 years for the exploration and development phase—that housing would be needed for the large number of OCS workers, it is assumed that temporary housing would be provided by OCS lessees for approximately half of the OCS workers in these 3 peak years. In the peak year 2000, temporary housing would be provided for about 550 OCS workers and permanent housing for the other 500 OCS workers.

Revenue from property tax would increase <2 percent for <5 years for the KPB. The value of taxable improvements to property during a peak year is estimated to be $50 million (1993 dollars), which is 1.6 percent of the total taxable valuation for the KPB in 1993 (Barnes, 1993, personal comm.). Primary components of taxable improvements are improvements in existing facilities equivalent to a new shore base and new housing for workers. It is assumed that 200 permanent housing units would be built for each year for the 4 years following exploration, 1999 to 2002. At an average value of $100,000 per housing unit, the average value of new housing per year would be $20 million. The value of improvements to shore-base facilities is estimated to be $30 million for the peak year. The values are given in 1993 dollars.

Annual property-tax revenue of $2.2 million would accrue to the KPB and $0.4 million (1993 dollars) to the State after all major improvements are constructed or installed, which would be 2002. The improvements are estimated to be $100 million for shore-base improvements and $80 million for 800 new housing units. The $180 million of improvements at the rate of 12 mills results in property-tax revenue of $2.2 million. The mill rate of 12 is the approximate average of the mill rates for seven tax-code areas between Anchor Point and Nikiski; the mill rate accruing to the State of Alaska for oil facilities in this case is 8 (Alt, 1993, personal comm.). It is assumed that half of the shore-base improvements are oil facilities.

If the KPB had a sales tax during the period of OCS activity, the expenditures by direct OCS workers and indirect workers would translate to a maximum sales-tax revenue change of <5 percent for <5 years. This is because the sales-tax revenue would be in proportion to the increase in total income for all additional OCS workers in 1 year; and it is assumed that the income for OCS workers would be twice that of the average worker for the western Kenai Peninsula.

Headquarters employment is assumed to be located in Anchorage. It would rise from 10 in 1995 to 100 in 2003, to 200 from 2004 through 2012, and drop to 180 from 2013 through 2021. It would result in changes that are <1 percent of Anchorage employment in any given year.

The economic effects of oil spills <1,000 bbl would be very minimal. These small spills would be cleaned up by CISPRI or some similar organization. A spill <1,000 bbl would require <50 person hours to clean up.

The most relevant historical experience in Alaskan waters of a tanker spill of 109,000 bbl (average tanker-size spill, Sec. IV.A.2.a(4)) is the EVOS of 1989, which spilled 240,000 bbl. This spill generated enormous employment that rose to the level of 10,000 workers directly doing cleanup work in relatively remote locations. Smaller numbers of cleanup workers returned in the warmer months each year following 1989 until 1992. Numerous local residents quit their jobs to work on the cleanup at often significantly higher wages. This generated a sudden and significant inflation in the local economy (Cohen, 1993). Anecdotal information indicates that housing rents in Valdez in 1989 increased from 25 percent in some cases to sixfold in others, and inflated rents continued into 1990. Prices of food and other goods increased only slightly, because people could drive to Anchorage to purchase them (Henning, 1993, personal comm.). Research shows that no data on inflation were gathered in a systematic way during the EVOS, although most observers agree that there was temporary inflation.

The number of cleanup workers actually used for a spill associated with Sale 149 would depend to a great extent on what procedures are called for in the oil-spill-contingency plan, how well prepared with equipment and training the entities responsible for cleanup are, how efficiently the cleanup is executed, and how well in reality the coordination of cleanup is executed among numerous responsible entities. A spill resulting from activity associated with Sale 149 could generate half the workers associated with the EVOS, or 5,000 cleanup workers. Housing rents in the western Kenai Peninsula probably would double for 1 year following a major spill.

Conclusion: Alternative IV would generate changes that are basically the same as for the base case. These changes would be between zero and 3 percent in resident employment, <3 percent in average income, <5 percent in cost of living, <2 percent in property tax, and <5 percent in sales taxes on the western side of the Kenai Peninsula annually for <5 years. Property-tax revenue of $2.2 million for the KPB and $0.4 million for the State (in 1993 dollars) would be added annually after the year 2002.

A large oil spill would generate 5,000 cleanup jobs for 6 months in the first year, declining to zero by the fourth year following the spill. Local communities would experience a doubling of housing rents for 1 year.

i. Effects on Commercial Fisheries: Activities and events associated with the Wildlife Concentration Deferral Alternative (Alternative IV) that may affect the Cook Inlet commercial-fishing industry include drilling discharges, offshore construction, seismic surveys, and oil spills. The effect of these activities and events on the Cook Inlet commercial-fishing industry are discussed in the base case (Sec. IV.B.1.i) and are summarized below. The following analysis for Alternative IV focuses on the differences in the amount of activity (the only variable) estimated for Alternative IV as compared to that of the base case. It then estimates the resulting effect of this difference on the Cook Inlet commercial-fishing industry for Alternative IV.

This alternative would delete 52 partial and whole blocks, or about 12 percent of the sale area discussed in the base case. This eliminates any OCS activity in the deferral areas and would eliminate them as areas where a platform oil spill could originate. The probability of a platform spill occurring is estimated to be 10 percent compared to 12 percent for the base case. However, platforms outside the deferral areas still would be a potential oil-spill source that could affect the deferral areas. Also, the probability of one or more oil spills occurring from a tanker or pipeline for the deferral areas would be only slightly less (1% and 2%, respectively) than the base case. Hence, in terms of an oil spill, the only difference between this alternative and the base case is the extra time it would take for a platform (now outside of the deferral areas for Alternative IV) spill to reach the deferral areas. While this extra time likely would reduce the toxicity of the oil entering the deferral areas, it likely would not reduce the severity of economic losses to the commercial-fishing industry due to closures. For these reasons, the effects of Alternative IV on the commercial-fishing industry are expected to be essentially the same as discussed for the base case; they are summarized below.

Drilling discharges associated with the base case are not expected to have an effect on commercial fishing due to the limited area affected near the platform-discharge point. Offshore construction, platforms, and pipelines are expected to result in some space-use conflicts (e.g., competition for docking space or gear loss); however, these are expected to be few in number and minor in scope. Seismic surveys, planned and coordinated with the commercial-fishing industry, are expected to have a minimal effect on the Cook Inlet commercial-fishing industry. Due to the relatively small amount of oil involved (555 bbl), the 39 small oil spills (Table IV.A.2-4d) assumed for the Wildlife Concentration Deferral Alternative, are not expected to result in closures or reduced market values over the life of the proposal. Hence, they are not expected to have a measurable economic effect on the Cook Inlet commercial-fishing industry. However, the assumed large (50,000-bbl) oil spill is expected to affect pot, longline, trawl, drift-gillnet, and set-gillnet fisheries in Cook Inlet.

The estimated economic effect of the large (50,000-bbl) oil spill on the Cook Inlet commercial-fishing industry is based on what occurred during the EVOS and GBOS, and primarily depends on the highly variable EVOS cost estimates (ranging from $9-43 million/year for 2 years). From 1983 to 1993, the value of the Cook Inlet commercial fishery appears to have ranged between about $50 and $135 million/year. Based on the above, in any 2-year period when the value of the Cook Inlet commercial fishery is estimated to be about $50 million/year, a 2-year loss of about $9 million/year represents an 18-percent/year loss for 2 years; whereas a 2-year loss of about $43 million/year represents an 86-percent/year loss for 2 years. In a 2-year period when the value of the Cook Inlet commercial fishery is estimated to be closer to $135 million/year, a 2-year loss of about $9 million/year represents a 7-percent/year loss for 2 years; whereas a 2-year loss of $43 million/year represents a 32-percent/year loss for 2 years. Because the occurrence of a large oil spill would preclude any knowledge of what the commercial fishery would have been worth, the value of the commercial fishery at the time of the assumed 50,000-bbl-oil spill is assumed to be the average annual value (1983-1993) of the Cook Inlet commercial fishery. Thus, in terms of the average annual value of the Cook Inlet commercial fishery (about $65 million), the assumed base-case oil spill is estimated to result in an economic loss of about 15 to 65 percent/year for 2 years. Estimated losses to the Kodiak commercial- fishing industry are expected to be less than half of those estimated for Cook Inlet, or about 5 to 25 percent/year for 2 years following the assumed 50,000-bbl Cook Inlet oil spill. This amounts to an estimated loss of about $4 to$19 million/year to the Kodiak commercial-fishing industry. However, the EVOS experience has demonstrated that compensation to the commercial-fishing industry for participating in the cleanup of a large Cook Inlet oil spill is likely to exceed these economic losses by several orders of magnitude.

Conclusion: Based on the assumptions discussed in the text (e.g., a 50,000-bbl spill occurs during the commercial-fishing season), EVOS-loss estimates, and the average annual value of the Cook Inlet and Kodiak commercial fisheries, the Wildlife Concentration Deferral Alternative is estimated to result in economic losses to the Cook Inlet commercial-fishing industry ranging from about 15 to 65 percent/year for 2 years following the assumed 50,000-bbl-oil spill. Losses to the Kodiak commercial-fishing industry from the same spill are estimated to range from about 5 to 25 percent year for 2 years following the spill. The chance of one or more oil spills ≥1,000 bbl is estimated to be 23 percent.

j. Effects on Subsistence-Harvest Patterns: The effects-producing factors for Alternative IV, the Wildlife Concentration Deferral Alternative, are the same as for the base case, including routine operations such as seismic surveys, the disposal of drilling muds and cuttings, and the operation of support facilities, as well as accidental events such as oil spills.

Geographically, the deferral of selected blocks of the proposed lease-sale area as buffers to protect coastal habitats near Tuxedni Bay or the Barren Islands could provide a measure of protection for subsistence resources. Besides selective block deferral, Alternative IV also differs from the base case in that 41 rather than 48 production and service wells would be drilled and 160 rather than 200 MMbbl of oil would be produced. Reduced effects on subsistence resources could occur from factors such as the discharge of reduced amounts of drilling muds and cuttings and reduced numbers of helicopter and vessel trips in comparison with the base case, although such reductions may not produce measurable effects reduction.

Other than these and other minor differences, the number of production platforms, the number and location of shore bases, and the number and location of pipeline landfalls are the same as the base case. Effects on subsistence-harvest patterns from operating these facilities should be the same as for the base case.

Effects on subsistence-harvest patterns from oil-spill events likewise would be essentially the same as the base case in that the production and transportation scenarios are the same as the base case. There is only a 6-percent reduction (21% vs. 27% in the base case) in the chance of one or more oil spills ≥1,000 bbl occurring and contacting land within 30 days of discharge, and most of the contacts with land segments occur on the western side of Cook Inlet relatively removed from subsistence-harvest areas (Appendix B, Tables B-14 and B-15).

As a consequence of the above, effects on subsistence-harvest patterns in Alternative IV would be most prominent among southern Kenai Peninsula communities and the communities of Nanwalek and Port Graham. These communities could experience subsistence-resource loss, primarily because of the high level of exposure to spills from transportation sources, should they occur. Such losses could include the lack of resource availability, accessibility, or desirability for use. Reductions in subsistence-harvest levels for specific resources could extend for a year, or more. Elsewhere in Cook Inlet and on Kodiak Island and the Alaska Peninsula, effects on subsistence-harvest patterns are estimated to be limited in magnitude and duration and not of such a nature as to cause measurable changes in the availability, accessibility, or desirability of most subsistence resources.

Conclusion: Effects on subsistence-harvest patterns are expected essentially to be the same as Alternative I (base case), in that subsistence harvests would be reduced or substantially altered by as much as 50 percent in one or more southern Kenai Peninsula communities for at least 1 year and, to a lesser extent, for selected subsistence resources 2 to 3 years beyond. However, deferral of selected blocks near Tuxedni Bay or the Barren Islands could provide a measure of protection for subsistence resources.

k. Effects on Sociocultural Systems: The effect-producing factors for Alternative IV, the Wildlife Concentration Buffer Deferral Alternative, include prelease and postlease planning processes, the introduction of industrial activities and changes in community population and/or employment levels, potential effects on subsistence-harvest patterns, and effects from accidental oil spills and cleanup efforts.

Effects on sociocultural systems begin with the prelease processes of announcing the proposed sale and carrying out the preparation of an EIS. Given a significant oil discovery, planning processes are again engaged to prepare a developmental EIS. Each of these sometimes lengthy processes causes stress and anxiety among affected publics, although the stakes would be different. The discussion under the base case (Sec. IV.B.1.k.) explores the types of impacts involved.

This alternative has the same technical characteristics as the base case regarding the number of production platforms, the number and location of shore bases, and the number and location of pipeline landfalls. Major differences from the base case include the drilling of 41 rather than 48 production and service wells and the production of 160 rather than 200 MMbbl of oil.

As discussed for the base case, it is more likely that the population associated with OCS-related industrial activities would be distributed within the central Kenai Peninsula area than according with the distribution of population established in the 1990 census of population. Accordingly, Table IV.B.4.k-1 shows this distribution to be about 1 percent less than the base case over time, with some minor differences in the years 2001 and 2002. In these years, the percentage of population increase in the mid-Peninsula area would be in the range of 2 to 3 percent under Alternative IV, as compared with the base case. Consequently, effects on sociocultural systems from population increases should be generally the same as for the base case.

Effects on subsistence-harvest patterns from oil-spill events would be the same as for the base case in that the number of spills assumed to occur and the production and transportation scenarios are the same as or similar to the base case. Likewise, effects from oil-spill and cleanup events would be the same as for the base case.

Table IV.B.4.k-1

Alternative Distribution of Sale-Related Resident Population within the Kenai Peninsula Borough (KPB): Mid-Peninsula Area; Alternative IV

Year	Mid-Peninsula Total Resident Population without Sale	Sale-Related Resident Population	Mid-Peninsula Resident Population with Sale	Mid-Peninsula Percentage of Increase
1997	19,848	659	20,507	3.2
1998	20,027	843	20,870	4.0
1999	20,207	1,915	22,122	8.7
2000	20,389	2,766	23,155	11.9
2001	20,572	3,526	24,098	14.6
2002	20,757	2,876	23,633	12.2
2003	20,944	2,016	22,960	8.8
2004	21,133	2,030	23,163	8.8
2005	21,323	2,016	23,339	8.6
2006	21,515	2,016	23,531	8.6
2007	21,708	2,016	23,724	8.5
2008	21,904	2,016	23,920	8.4
2009	22,101	2,030	24,131	8.4
2010	22,300	2,068	24,368	8.5
2011	22,501	2,054	24,555	8.4
2012	22,703	2,040	24,743	8.2
2013	22,907	2,016	24,923	8.1
2014	23,114	2,015	25,129	8.0
2015	23,322	2,016	25,338	8.0
2016	23,531	2,016	25,547	7.9
2017	23,743	2,016	25,759	7.8
2018	23,957	2,016	25,973	7.8
2019	24,173	2,015	26,188	7.7
2020	24,390	2,016	26,406	7.6

Source: MMS, Alaska OCS Region.

As a consequence of the above, effects on sociocultural systems in Alternative IV would be centered on the Kenai Peninsula, including the Alutiiq communities of Nanwalek and Port Graham. Resident population associated with the sale would do little to change existing sociocultural systems in the central Kenai Peninsula area, where new resident population would be expected to live. Despite the limited chance that one or more oil spills ≥1,000 bbl would occur and contact land, the individual, social, and institutional effects from these and tanker spills, should they occur, could be serious. Individual and social stress and anxiety levels would be expected to increase in southern Kenai Peninsula communities over the loss of subsistence resources, contamination of habitat, fear of the health effects of eating contaminated wild foods, and the need to depend on the knowledge of others about environmental contamination. In the Alutiiq communities, the organization of subsistence activities among kinship and friendship groups and the relationships among those that customarily process and share subsistence harvests also could be modified or could decline in importance. Stress-induced increases in alcohol and drug abuse would produce increases in numerous substance-abuse problems, such as child abuse, domestic violence, and accidents. The duration of individual and social effects would depend on the severity of the oil-spill experience. Institutionally, communities would undergo considerable disruption and community conflict, with litigation constituting a secondary source of postspill social and community stress.

Conclusion: Effects on sociocultural systems are expected essentially to be the same as Alternative I (base case), in that one or more southern Kenai Peninsula communities would undergo periodic episodes of increased individual, social, and institutional stress and disruption that would last for several years in each instance and endure in memory for decades; effects are caused by both prelease and potential postlease processes and events.

l. Effects on Archaeological and Cultural Resources: Deferral of the wildlife concentration buffer area should reduce effects on archaeological and cultural resources located in the deferral area, because it would lower the possibility of interaction from workers or the chance of contact from spilled oil. Besides selective block deferral, Alternative IV also differs from the base case in that 41 rather than 48 production and service wells would be drilled and 160 rather than 200 MMbbl would be produced.

If a spill should occur, deferring the blocks east of LS's 31 through 34 would offer some reduction in the chance of contact by removing some portion of the >5- and <25- and >25- and <50-percent 3-day winter-estimated chance of contacting those land segments (Johnson et al., 1993). Deferring the blocks east of LS's 18 through 23 would offer some reduction in the chance of contact by removing some portion of the >5- and <25-percent 3-day winter-estimated chance of contacting resources offshore and onshore in the area of those land segments (Johnson et al., 1993, Appendix B, Figs. B-16, B-17, and B-18). For Alternative IV, some (1-2%) reduction in the combined probabilities is shown for the following areas: the Alaska Peninsula from Hallo Bay north to include the Cape Douglas area (LS's 19, 21, and 22), the forelands north of Chinitna Bay to Tuxedni Bay (LS 31), Kalgin Island (LS 35), the Nikishka area on the Kenai Peninsula (LS 40), and Kachemak Bay and western Barren Islands (LS's 44 and 47) (Appendix B, Tables B-14 and B-15). The chance of contact from an oil spill during the summer season after 30 days would not be lowered from pipeline and tanker segments and, therefore, the risk of effect, would not be removed for LS's 58 through 74, LS's 15 through 22, and LS's 32 through 36. An estimated 150 sites are in that area, and disturbance would be <3 percent, or <5 sites, the same as for the base case for the above-mentioned land segments (see Sec. IV.B.1.1).

Conclusion: It is estimated that this alternative would not result in a significant lowering of the effect of the base case. Less than 3 percent of the archaeological sites (an estimated 30 sites) and shipwrecks on the shore and within the State's 3-mi zone would be affected.

m. Effects on National and State Parks and Related Recreational Places: Deferral of the wildlife concentration buffer area should reduce effects resources of national and State parks and related recreational places located in the deferral area, because it would lower the possibility of interaction from workers on the chance of contact from spilled oil. Besides selective block deferral, Alternative IV also differs from the base case in that 41 rather than 48 production and service wells would be drilled and 160 rather than 200 MMbbl of oil would be produced.

If a spill should occur, deferring the blocks east of LS's 31 through 34 would offer some reduction in the chance of contact by removing some portion of the >5- and <25- and <50-percent 3-day winter-estimated chance of contacting those land segments (Johnson et al., 1993). Deferring the blocks east of LS's 18 through 23 would offer some reduction in the chance of contact by removing some portion of the >5- and <25-percent 3-day winter-estimated chance of contacting resources offshore and onshore in the area of those land segments (Johnson et al., 1993; Appendix B, Figs. B-20, B-21, and B-22). For Alternative IV, some (1-2%) reduction in the combined probabilities is shown for the following areas: the Alaska Peninsula from Hallo Bay north to include the Cape Douglas area (LS's 19, 21, and 22), the Forelands north of Chinitna Bay to Tuxedni Bay (LS 31), Kalgin Island (LS 35), the Nikishka area on the Kenai Peninsula (LS 40), and Kachemak Bay and western Barren Islands (LS's 44 and 47) (Appendix B, Tables B-12 and B-15). The chance of contact from an oil spill during the summer season after 30 days would not be lowered from pipeline and tanker segments and, therefore, the risk of effect would not be removed from LS's 68 through 74, LS's 15 through 22, and LS's 32 through 36. The chance of contact and wear and tear from visitors and vandalism of the shore and intertidal zone habitats would be the same as in the base case.

Conclusion: It is estimated that this alternative would not result in a lowering of the effect of the base case. Less than 3 percent of the national and State parks and related recreational places would be affected for a period of <3 years.

n. Effects on Air Quality: Air-quality regulations and procedures are discussed in Section IV.B.1.n, the base case. That discussion also describes the methodology used to model the air-quality effects associated with this proposed lease sale. The EPA-approved OCD model was used to calculate the effects of pollutant emissions from the proposal on onshore air quality. Because the Class I PSD areas allow for the least amount of degradation, the modeling scenario (i.e., source location) chosen for this analysis is the one that results in the maximum-potential effect to the air quality of the designated national wilderness area of the Tuxedni National Wildlife Refuge, the only Class I area adjacent to the pro- posed sale area. The maximum-potential effect at any location in the Class II area would be the same. In all likelihood, effects to the Tuxedni National Wilderness Area would be lower than those calculated by the model.

For Alternative IV, peak-year emissions from exploration would be from drilling one to two exploration wells and two to three delineation wells from one rig. Peak-year emissions from development would include platform and pipeline installation and the drilling of 20 production wells from two rigs. Peak-year production emissions would result from operations (producing 17 MMbbl of oil) and transportation. Table IV.B.1.n-1 lists estimated uncontrolled-pollutant emissions for the peak-exploration, peak-development, and peak-production years. Due to the configuration of the deferral area, the sale area would be 24 km (15 mi) off of Chisik Island (within the national wilderness area of the Tuxedni National Wildlife Refuge). This is significant because the air-quality modeling assumed maximum effect to the air quality of the national wilderness area. Alternative IV provides a greater distance between the Class I area and the proposed action, thus reducing the already assessed minimal effect to air quality from the base case. Alternative IV also defers those portions of the sale area west of the Barren Islands.

Under the Federal and State of Alaska PSD regulations, because the estimated annual uncontrolled NO_2 emissions for peak-development year would exceed 250 tons per year, the lessee would be required to control NO_2 emissions through application of BACT to emissions sources to reduce NO_2 concentration (other pollutants were also modeled; however, NO_2 had the highest concentrations—which were well within PSD increments and air-quality standards), averaged over a year would be 0.19, 0.51, and 0.14 $\mu g/m^3$, respectively, at the shoreline; 7.6, 20.4, and 5.6 percent, respectively, of the available Class I increment for NO_2; and .76, 2.04, and .56 percent, respectively, for Class II. The existing air quality would be maintained by a large margin.

For a more-detailed discussion of the potential effects of air pollution—other than those effects addressed by standards—see Section IV.B.1.n. The amount of air pollutants reaching the shore is expected to be very low spatially and temporally because of the small amount of emissions from exploration, development, and production activities and their distance from shore. The probability of experiencing one or more blowouts in drilling the 41 wells projected for Alternative IV is estimated to be 8 to 11 percent. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore due to exploration and development/production or accidental emissions would not be sufficient to harm vegetation on more than a short-term basis, even locally. A light, short-term coating of soot over a localized area could result from oil fires. Consequently, the effects of air-pollutant emissions under Alternative IV are expected to be minimal.

Conclusion: The effects associated with this alternative essentially would be the same, qualitatively, as those discussed for the Alternative I base case. Alternative IV provides reduction in air-quality effects to onshore resources due to the deferral of areas nearshore from potential exploration, development, and production activities. Effects on onshore air quality analyzed for this alternative are expected to be 20.4 percent of the maximum allowable PSD Class I increments. Only the Tuxedni National Wilderness Area is designated Class I, with the remaining area in and adjacent to the sale area designated Class II. Therefore, the potential effects would be much less. These effects would not make the concentrations of criteria pollutants in the onshore ambient air approach the air-quality standards. Consequently, a minimal effect on air quality with respect to standards is expected. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore from exploration, development, and production activities and accidental emissions would not be sufficient to harm vegetation. A light, short-term coating of soot over a localized area could result from offshore oil fires.

o. Effects on Coastal Zone Management: The Wildlife Concentration Buffer Deferral Alternative defers the area near Chisik, Duck, and the Barren Islands. As a result, these areas receive some protection because exploration and development and production activities would not occur nearby, and oil spills would be kept farther offshore. Development associated with the sale would be similar to that hypothesized for the base case, and potential pipeline and tanker spills would remain the same as those assumed in the base case. Although the areas protected would be situated farther from any potential platform spill, spills along the transportation routes still pose some risk to these habitats and associated resources. As a result, the Statewide standards that applied to the hypothetical developments associated with the base case apply to the Wildlife Concentration Buffer Deferral Alternative. Those covered in the analysis include coastal development; geophysical-hazard areas; recreation; energy facilities; transportation and utilities; fish and seafood processing; subsistence; habitats; air, land, and water quality; and historic, prehistoric, and archaeological resources. Potential conflict with many of these Statewide standards and the associated district policies often is unknown until a specific plan is submitted; however, a potential for conflict was identified with the habitat standard. The ACMP provides a format for mitigating potential conflicts. The MMS operating procedures and the mitigating measures associated with this sale, especially the ITL clauses for Oil-Spill-Contingency Response, Bird and Marine Mammal Protection, Sensitive Areas to be Considered in Oil-Spill Contingency Plans, Coastal Zone Management, and the stipulations on Density Restriction Related to Commercial Fishing Uses, and Minimizing Potential Conflicts Between Oil and Gas Industry and Fishing Activities, provide additional mechanisms to ensure that activities that may follow this sale avoid conflict with the ACMP.

Conclusion: As in the base case, potential conflict with the habitat standard of the ACMP is possible. Site-specific information is necessary to ensure there is no conflict with the policies related to coastal development; geophysical hazards; energy-facility siting; transportation and utilities; subsistence; air, land, and water quality; and historic, prehistoric, and archaeological resources. Conflict is not inherent in the scenario.

5. Alternative V, Coastal Fisheries Deferral Alternative:

Description of Alternative V: This alternative would offer for leasing 250 blocks (1.33 million acres) located in the central part of the planning area in lower Cook Inlet (Fig. II.D.1). The subarea removed by the deferral alternative consists of 153 whole and partial blocks (647,494.82 acres), about 33 percent of the Call area. The blocks proposed for deferral lie around the perimeter of much of the planning area in lower Cook Inlet. The perimeter subarea varies from one- to six-blocks wide (approximately 3-18 mi).

The blocks proposed for deletion from the sale area by this deferral alternative include some of the blocks proposed for deletion by Alternative IV—Wildlife Concentration Buffer Deferral. Deleting the blocks identified in Figure II.D.1 would address certain fisheries-related concerns, including that (1) the proposed sale area north of Anchor Point lies within the heart of the Cook Inlet salmon gillnet fishery, and (2) parts of the sale area between Kalgin Island and Cape Douglas have been identified as being important to critical fish and wildlife resources. Opposition to leasing in these areas also has been registered because of (1) the perception that there is a potential conflict between commercial-fishing activities and oil-industry operations; (2) the high risk that an oil spill poses to the biological resources; and (3) the lack of technology sufficient to successfully contain and clean up a major spill in Cook Inlet as demonstrated by a recent spill (Kenai Pipe Line Co. oil spill of January 4, 1992, in Nikiski).

Resource Estimates and Basic Exploration, Development, and Production Transportation Assumptions for Effects Assessment: The resources for this alternative are assumed to be 140 MMbbl, approximately 30-percent less than Alternative I. Accordingly, resource-exploration and -development of oil activity also would be somewhat less than for the Proposal. Reviewing Table IV.A.1-1, Alternative V has 5 rather than 8 exploration-period wells, 2 rather than 3 production platforms, 60 percent of the production and service wells (29), and only 100 mi of subsea pipeline, as compared to 125 mi for Alternative I. Most other exploration, production, and transportation assumptions, including developmental timeframes, life of field, and facility locations, as discussed in the base-case scenario of the proposed action, virtually will be the same for this alternative. Please see Table IV.A.1-1.

Probability of One or More Spills Greater than or Equal to 1,000 Barrels Occurring: For this deferral alternative, there is a 19- percent probability of one or more spills ≥1,000 bbl occurring as compared to 27 percent for Alterative I (base case) (Table IV.A.2-2). The probability of one or more spills ≥1,000 bbl from (1) platforms is 8 percent, (2) pipelines is 9 percent, and (3) tankers is 4 percent as compared to 12, 13, and 6 percent, respectively, for Alternative I (base case) (Appendix B, Table B-1).

a. Effects on Water Quality: For Alternative V, the activities associated with petroleum exploitation most likely to affect water quality in the CI/SS sale area are (1) the permitted discharges from exploration-drilling units and production platforms, (2) accidental oil spills, and (3) construction activities. Selecting the Coastal Fisheries Deferral Alternative would reduce the economically recoverable oil resources assumed for analysis from 200 MMbbl (Alternative I base case) to an assumed 140 MMbbl. The types of activities associated with exploiting the potential oil resources of this alternative are the same as for Alternative I (base case), but the level of activities are reduced (Table II.A.1). The types and levels of activities include the number of wells drilled and quantities of muds and cuttings discharged, the number of production platforms and the types and quantities of discharges, the number of pipeline miles, and the number of oil spills and the amount spilled (Tables II.A.2-1, II.A.2-2, IV.A.2-2, and IV.A.2-4). The characteristics of the discharges, spills, and activities and their potential effects on water quality are described in Section IV.B.1.a and summarized in this section.

The benefits of this deferral alternative are derived from (1) a reduced level of drilling and production activities associated with the exploration for and production of an assumed 140 MMbbl of oil and (2) the exclusion of exploration-drilling units and production platforms from locating in the deferred areas—about 33 percent of the Sale 149 Call area; these areas are shown in Figure II.E.1. Compared to Alternative I (base case), the reduced level of drilling and production activities would result in a decrease in the amount of material discharged into the waters of Cook Inlet. Based on information from Table IV.B.1.a-2, the discharges would be reduced by about (1) 31 to 39 percent for the drilling muds, (2) 39 percent for the cuttings, and (3) 30 percent for the produced waters. Excluding the drilling units and production platforms from the deferred areas eliminates the direct release of the permitted discharges into the waters of these areas.

The hydrodynamic processes in the Cook Inlet Planning Area suggest the water column generally is well mixed, and dilution would reduce the concentration of the substances in the discharges. Degradation processes also act to continuously reduce the concentrations of many substances deliberately or accidentally released into the environment.

Of the permitted discharges, drilling muds and cuttings and produced waters are the most significant discharges associated with offshore operations. The permitted discharges would add substances that may be foreign to or increase the concentration of constituents already present in the water column of CI/SS. This analysis will consider (1) the chronic criterion (for the protection of marine life) for SPM/turbidity to range from 100 to 1,000 mg/l (Sec. IV.B.1.a(1)(a)1)), (2) 15 μg/l to be the chronic criterion (for the protection of marine life) and 1,500 μg/l—a hundredfold higher level—to be the acute criterion for total hydrocarbons (Sec. IV.B.1.a(1)(b)2)a)), and (3) 10 μg/l to be the chronic criterion (for the protection of marine life) and 1,000 μg/l to be the acute criterion for TAH (Sec. IV.B.1.a(1)(b)2)a)). In general, the added substances may cause sublethal effects in some marine organisms if concentrations are greater than the chronic criteria and lethal effects if concentrations are greater than acute criteria.

Drilling of the 2 exploration, 3 delineation, and 29 production and service wells could result in the discharge of an estimated 4,120 to 12,530 tons (dry weight) of drilling-mud components and 18,440 tons (dry weight) of cuttings (Table VI.B.1.a-2). The concentrations of discharged drilling muds initially may range from about 1,000 to 2,000 g/l and are expected to be greater than the SPM turbidity chronic criteria, 100 to 1,000 mg/l, assumed for this analysis. However, within about 100 to 200 m of the discharge point, mixing in the water column would reduce the concentrations by a factor of 10,000 to 1,000,000; the diluted concentrations are estimated to range from 1 to 200 mg/l. The concentration of suspended particulate matter in lower Cook Inlet and Shelikof Strait ranges from about 1 to 50 mg/l. Most of the solids in the discharges settle rapidly to the seafloor, where bottom currents disperse the finer particles. The drilling discharges are expected to take place over a 5- or 6-year period—most of the discharges would occur in the last 3 years and be associated with the drilling of the production and service wells.

Produced waters constitute the largest source of substances discharged into the marine environment, and their discharge is an issue of significant concern because of the types and amounts of naturally occurring substances they may carry and the manmade substances that may be added. The amount of produced water that would be discharged as a consequence of producing an assumed 140 MMbbl of oil in 19 years is estimated to range from about 13 to 104 MMbbl, or more (Table IV.B.1.a-2). The toxicity of produced waters mainly is caused by hydrocarbons that include nonvolatile hydrocarbons (USEPA oil and grease) and aromatic hydrocarbons. The discharges associated with production activities are expected to last for the life of the field(s), at least 19 years, and the rates increase with time. The concentrations of nonvolatile hydrocarbons and TAH in the produced waters are estimated to range from 19 to 36 mg/l (19,000-36,000 μg/l) and 8 to 13 mg/l (8,000-13,000 μg/l), respectively.

The dilution rates for the produced waters are estimated to range from about 1,000:1 to 1,000,000 within several hundred meters of the discharge site. If dilutions are based on a rate of 1,000:1, the concentrations of nonvolatile hydrocarbons (oil and grease) within several hundred meters of the platform might range from 19 to 36 μg/l and the concentrations of TAH might range from 8 to 13 μg/l. These concentrations are well below the acute criteria of 1,500 μg/l for the nonvolatile hydrocarbons and 1,000 μg/l for the TAH that were assumed for this analysis but, in general, slightly greater than the chronic criteria of 15 μg/l for the nonvolatile hydrocarbons and 10 μg/l for the TAH. If dilutions rates are about 10,000:1, the concentrations of nonvolatile hydrocarbons might range from about 2 to about 4 μg/l and the concentrations of TAH might be about 1 μg/l; these concentrations are less than the respective chronic criteria assumed for analysis. When discharged, the toxicity of the produced waters is expected to range from slightly toxic to practically nontoxic and will decrease with continued mixing in the water column.

The characteristics of the other constituents of the produced waters or other production-related discharges are expected to be within the USEPA criterion and/or be diluted in the water column within an area <2 km^2 to background concentrations or levels that would not cause sublethal to lethal effects in marine organisms.

The potential effects in any of the areas where there are permitted discharges would last for about (1) 2 to 3 months for each exploration well drilled and (2) 22 years for development and production activities. Future procedures and technologies of treating and handling drilling muds and cuttings and produced waters may reduce or eliminate the amounts discharged.

Accidental oil spills introduce into the water column a variety of hydrocarbon compounds whose concentrations may cause sublethal to lethal effects in marine organisms. Hydrodynamic and meteorological forces increase the areal extent of the spill and physical, chemical, and microbiological forces degrade the oil and reduce its concentration and toxicity.

The number of small (<1,000-bbl) accidental oil spills that might occur if oil is produced is estimated to be 34; the total volume of oil spilled is estimated to be 325 bbl (33 spills that average 5 bbl in size and one 160-bbl spill) (Tables IV.B.2.4b and 4c). At the end of 3 days assuming no cleanup, the oil from a small spill may be dispersed in a 1- to 10-square kilometer (km^2) area in concentrations of about 20 to 61 $\mu g/l$. The concentration of the dispersed oil 10 days after a spill is estimated to be between 3 and 14 $\mu g/l$ in an area of about 9 to 48 km^2 and, after 30 days, <1 to about 1 $\mu g/$ in an area of 34 to 199 km^2. During the 3- to 30-day interval following a small spill, the concentration of oil in the water column is not expected to exceed the total hydrocarbon acute criterion, 1,500 $\mu g/l$, assumed for this analysis; however, the concentration of spilled oil is expected to exceed the assumed total hydrocarbon chronic criterion, 15 $\mu g/l$, for several days to weeks.

There is a 19-percent chance that one or more spills ≥1,000 would occur but, if it did, the size of the spill is estimated to be about 50,000 bbl (Table IV.A.2-2). For a summer spill, the concentration of total hydrocarbons in the water column from a large spill is not expected to exceed the chronic criterion (1,500 $\mu g/l$), at least after 3 days, but may exceed the acute criterion (15 $\mu g/l$), for more than 30 days. In the summer at the end of 3 days assuming no cleanup, the oil from a large spill may be dispersed in a 190-km^2 area in concentrations of about 711 $\mu g/l$. The concentration of the dispersed oil 10 days after a spill is estimated to be about 163 $\mu g/l$ in an area of about 912 km^2 and after 30 days, 21 $\mu g/l$ in an area of about 3,715 km^2.

If the spill occurred in the winter, the size of the affected areas after the 3-, 10-, and 30-day-time intervals would be less than for a summer spill, but the concentration of oil in the water column would be greater. The oil in the water column is not expected to exceed the total hydrocarbon acute criterion (1,500 $\mu g/l$) during the (1) 3- to 30-day interval following a large spill under open-water conditions and (2) 10- to 30-day interval after a large spill in broken ice. During the 3- to 10-day interval following a large spill, the oil in the water column is expected to exceed the total hydrocarbon acute criterion (1,500 $\mu g/l$) under broken-ice conditions. The concentration of total hydrocarbons in the water column during the winter may exceed the acute criterion (15 $\mu g/l$) for >30 days.

Construction activities would increase the turbidity in the water column along segments of a 100-mi corridor for about 1.7 to 3.4 months, but there would be no overall degradation of the water quality.

Summary: The discharge of drilling muds and cuttings and other discharges associated with exploration drilling are not expected to have any effect on the overall quality of the Cook Inlet water. Within a distance of between 100 and 200 m from the discharge point, the turbidity caused by SPM in the discharged muds and cuttings is expected to be diluted to levels that are less than the chronic criteria (100-1,000 mg/l) and within the range associated with the variability of naturally occurring SPM concentrations. Mixing in the water column would reduce the toxicity of the drilling muds which, in general, are practically nontoxic, to levels that would not be harmful to organisms in the water column. In general, the amounts of additives in the other discharges are expected to be relatively small (from 1 to 100 or 200 g/month) and diluted with seawater several hundred to several thousand times before being discharged into the receiving waters.

The discharge of produced waters is not expected to degrade the quality of Cook Inlet water. Mixing and weathering processes continuously will reduce the concentrations of the hydrocarbons in the produced waters. Mixing is expected to reduce the concentrations of the nonvolatile hydrocarbons and TAH's to concentrations that are less than the chronic criteria of 15 $\mu g/l$ and 10 $\mu g/l$, respectively. The pH of the produced waters is expected to be within the range specified by the USEPA. The salinities of the produced waters would be within the range of salinities that are found in Cook Inlet. The discharge of metals, as indicated by zinc, generally would be less than the amounts streams and rivers discharge into Cook Inlet. Mixing in the water column would reduce the toxicities of the produced waters which, in general, may range from slightly toxic to practically nontoxic prior to discharge.

Small oil spills, as represented in this analysis by 5- and 160-bbl spills, are not expected to have any degradational effects on the overall water quality of Cook Inlet. The small spills would degrade the water quality for a relatively short period of time, perhaps up to about 10 days, in areas of less than about 50 km^2. As noted in Section

III.A.5.c(4)(e), the concentration of any of the various types of hydrocarbons in the water column generally are quite low or below detection limits.

A large oil spill (≥ 1,000 bbl), as represented in this analysis by a spill of 50,000 bbl of crude oil, would degrade the quality of Cook Inlet water for a period of about a month or longer in an area that might extend over several thousand square kilometers; the probability of such a spill occurring is estimated to be 19 percent. If the spill occurs within a relatively short period of time, as measured in hours, the hydrocarbon concentration in the water column generally is expected to be less than the acute criterion (1,500 μg/l) within several days. However, the hydrocarbon concentration may remain greater than the chronic criterion (15 μg/l) for a month, or more.

Conclusion: The permitted, routine discharges associated with oil and gas development and small (< 1,000-bbl) oil spills are not expected to cause any measurable overall degradation of Cook Inlet water quality; routine discharges would be prohibited in the deferred areas (about 33% of the Sale 149 area) and the amounts discharged reduced (about 30-40%). Water quality would be reduced from good (unpolluted) to polluted by the presence of hydrocarbons from one or more large (≥ 1,000-bbl) oil spills, which have a relatively low chance (19%) of occurring. Contamination (the presence of hydrocarbons in amounts > 15 μg/l) would be temporary (last for a month, or more) and affect an area of several thousand square kilometers.

b. **Effects on Lower Trophic-Level Organisms:** Routine activities associated with the Coastal Fisheries Deferral Alternative (Alternative V) that may affect lower trophic-level organisms include seismic surveys, drilling discharges, and dredging or construction. Accidental activities include exposure to petroleum-based hydrocarbons from an oil spill. The effects of these routine and accidental activities on lower trophic-level organisms are discussed in the base case (Sec. IV.B.1.b) and are summarized below. The following analysis for Alternative V focuses on the differences in the amount of activity (the only variable) estimated for Alternative V, as compared to that of the base case. It then estimates the resulting effect of this difference on lower trophic-level organisms for Alternative V.

Alternative V would delete 153 partial and whole blocks, or about 33 percent of the sale area discussed in the base case. This would eliminate any OCS activity in the deferral areas and would eliminate them as areas where a platform oil spill could originate. However, platforms outside the deferral areas still would be a potential oil-spill source that could affect the deferral areas. More importantly, the probability of one or more ≥ 1,000-bbl oil spills occurring from an oil tanker or pipeline (the primary oil-spill sources) for the deferral areas would be nearly the same (2-4%) as the base case (Appendix B, Table B-1). Hence, in terms of an oil spill, the essential difference between Alternative V and the base case is the extra time it would take for a plat- form (now outside of the deferral areas for Alternative V) spill to reach deferral-area shorelines. This extra time would reduce the amount of toxic hydrocarbons reaching deferral-area shorelines. However, the surface oil (the most damaging aspect of spilled oil) still would reach these shorelines. Further, because of the speed of water movement in Cook Inlet/Shelikof Strait, the reduction in toxicity that would occur while the oil was traversing the deferral areas (although large for Alternative V) may be relatively small, depending on where the spill originated. For these reasons, and because there only would be a minor change from the base case in the probability of an oil spill from the primary oil-spill contributors (tankers and pipelines), the effects of Alternative V on lower trophic-level organisms are expected to be essentially the same as discussed for the base case, and are summarized below.

Seismic surveys are expected to have little to no effect on lower trophic-level organisms. Drilling discharges are estimated to affect < 1 percent of the benthic organisms in the sale area and none of its plankton. Recovery is expected to occur within 1 year. Dredging and construction are expected to have little or no effect on plankton communities. Less than 1 percent of the immobile benthic organisms would be affected. Immobile benthic communities affected by pipeline construction are expected to recover in < 3 years. The effects of petroleum-based hydrocarbons on phytoplankton, zooplankton, and benthic organisms range from sublethal to lethal. Where flushing times are longer and water circulation is reduced (e.g., bays, estuaries, and mudflats), adverse effects are expected to be greater, and the recovery of the affected communities is expected to take longer. Large-scale effects on plankton due to petroleum-based hydrocarbons have not been reported. Assuming that a large number of phytoplankton were contacted by an oil spill, the rapid replacement of cells from adjacent waters and their rapid regeneration time (9-12 hours) would preclude any major effect on phytoplankton communities. Observations in oiled environments have shown that zooplankton communities experienced short-lived effects due to oil. Affected communities appear to rapidly recover from such effects because of their wide distribution, large numbers, rapid rate of regeneration, and high fecundity. Large-scale effects on marine plants and invertebrates due to petroleum-based hydrocarbons have not been reported. The sublethal effects of oil on marine plants include reduced growth and photosynthetic and reproductive activity. The sublethal effects of oil on marine invertebrates include adverse effects on reproduction, recruitment, physiology, growth, development, and behavior (feeding, mating, and habitat selection).

Based on the assumptions discussed in the text (see Sec. IV.B.1.b), the assumed oil spill for Alternative V is estimated to have sublethal and lethal effects on 1 to 5 percent of the phytoplankton and zooplankton populations in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. The total percentage of plankton affected could increase to 5 percent if many embayments were contacted by the spill. Recovery within the affected embayments is expected to take 1 to 2 weeks. Marine plants and invertebrates in subtidal areas are not likely to be contacted by an oil spill, but marine plants and invertebrates in intertidal and shallow subtidal areas are likely to be contacted by an oil spill. Based on the assumptions discussed in the text (see Sec. IV.B.1.b), the assumed oil spill for Alternative V is estimated to have lethal and sublethal effects on about 20 to 30 percent of the intertidal and shallow subtidal marine plants and invertebrates in the sale area. Recovery of these communities is expected to take 2 to 3 years in high-energy habitats and up to 7 years in lower energy habitats. Small oil spills (estimated total of 325 bbl) may adversely affect individual lower trophic-level organisms in small areas immediately around the spills (Table IV.A.2.4-d). However, they are not expected to have perceptible effects on lower trophic-level organisms at the population level.

Conclusion: Alternative V is expected to have essentially the same effect as that of the base case. The assumed oil spill associated with Alternative V is estimated to have lethal and sublethal effects on 1 to 5 percent of the plankton in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 2 weeks for zooplankton. It also is estimated to have lethal and sublethal effects on about 20 to 30 percent of the intertidal and shallow subtidal marine invertebrates in the sale area. Recovery of these communities is expected to take 2 to 3 years in high-energy habitats and up to 7 years in lower energy habitats. Less than 5 percent of the subtidal benthic populations in the sale area are expected to be affected. All of the above effects are based on the assumptions discussed in the text (e.g., the 50,000-bbl-oil spill occurs, and land segments having a probability of occurrence and contact ≥ 1 percent are contacted).

c. Effects on Fisheries Resources: This deferral alternative removes lease blocks from the sale area that are important to coastal fisheries. This reduces the probability of a spill from platforms and reduces the amount of noise and disturbance in and around certain coastal- fisheries resources. The effect of this deferral alternative will be examined using 30-day conditional probabilities for the summer season on the most- sensitive fishery resource areas in the sale area that could be affected under the base case. Effects on fisheries due to (1) oil spills and oil pollution, (2) noise and disturbance, and (3) habitat loss and/or alteration were analyzed and appear in full under the base case (Sec. IV.B.1.c).

The effects of an oil spill were reviewed for fisheries resources in the sale area. Sale-specific oil-spill effects on fisheries resources were estimated using combined probabilities generated from the OSRA model. Effects on fisheries derived from the EVOS studies were used to estimate potentially lethal effects of an oil spill on fisheries resources. Sale-specific oil-spill effects are not expected to directly affect returning adult salmon or steelhead. Oiled intertidal areas could cause an increased mortality to pink salmon eggs in the affected areas, but the increased egg mortality is not expected to cause reduced adult survival. An increased level of developmental malformations and increased egg-larval mortality could cause reduced survival to adulthood in herring populations affected by an oil spill. These effects are expected to be limited to the year-class spawned during the spill year and be masked to some extent by the contribution of other year-classes to the herring population. Eggs and larvae of some semidemersal and demersal fishes may suffer increased mortality from oil contact. Also, some demersal fish populations could be exposed to oil in the event of a spill, and a few individuals could be killed. But based on experience of the EVOS, it is unlikely there would be any population-level effects to demersal fishes.

Indirect effects such as ingesting oil from contaminated food could cause slower growth of pink salmon juveniles due to the metabolic cost of depurating the hydrocarbon burden. This may cause an incremental reduction in survival to adulthood but is not expected to have population-level effects.

Fisheries resources could be disturbed and displaced from the immediate vicinity of drilling discharges, within a radius probably not to exceed 100 m. These effects on demersal fishes very likely would be limited to only the short time periods of the discharge. Offshore construction also could temporarily disturb and/or displace fisheries resources. Any disturbance or displacement should be short term (hours to days), limited to only the time of construction and shortly thereafter. Though seismic surveys may damage eggs and larvae of some fishes, this injury is limited to within a meter or two from the airgun-discharge ports. Thus, seismic surveys probably would have no appreciable adverse effects on fish populations.

The Coastal Fisheries Deferral Alternative buffer zones are effective in reducing risk to fishery resources in lower Cook Inlet. Based on the summer 30-day conditional risk contours, the chance of spill contact due to production is greatly reduced in Tuxedni Bay (ERA 1) and inner and outer Kamishak Bay (ERA's 5 and 4) where there is an estimated chance of contact as high as 95 percent (Appendix B, Figs. B-1, B-5, and B-4). Most of the reduced risk is in Tuxedni Bay and outer Kamishak Bay in areas with a chance of contact >95 percent, while most of the area of reduced risk in inner Kamishak Bay is in areas where the chance of contact is >50 and <95 percent. There also is reduced risk in all three areas where the chance of contact ranges between >5 to <50 percent, although some chance of contact between >25 to <75 percent is eliminated from Tuxedni Bay as well. Other areas in lower Cook Inlet with reduced risk because of the deferral are Chinitna Bay (ERA 2), Kachemak Bay (ERA 3), and the Barren Islands and Cape Douglas (ERA 7). Most of the reduced risk to these areas is in regions where the chance of contact is between >5 to <25 or >5 to <50 percent. This alternative reduces risk to outmigrating salmonid smolts along western Cook Inlet in the vicinity of Tuxedni Bay to Chinitna Bay and eastern Cook Inlet from the Kenai River south to the Anchor River. In particular, the coastal fisheries deferral affords some protection to intertidally spawning pink salmon populations within Kachemak Bay. The coastal fisheries deferral also reduces some risk of platform and pipeline spills to demersal fishes (halibut and cod) around the Barren Islands and Cape Douglas.

In summary, the estimated spill effects under the coastal fisheries deferral would be unchanged from the base case. Adult salmon and steelhead should not be affected. Oiled intertidal areas have the potential for increased mortality to pink salmon eggs, and some juvenile pink salmon could have slower growth rates due to ingestion of oil-contaminated food. There could be an increased level of developmental malformations and increased egg-larval mortality in herring. Eggs and larvae of some demersal and semidemersal fish also could suffer some increased mortality. The short-term, local effects of noise disturbance and habitat alteration would be lessened for the fisheries resources in the deferral area. These include outmigrating salmonid smolts along western and eastern Cook Inlet, pink salmon populations within Kachemak Bay, and demersal fishes, primarily halibut and cod, around the Barren Islands to Cape Douglas.

__Conclusion__: Compared to the base case, the estimated spill effects would be unchanged, with the potential for increased mortality in pink salmon eggs and an increased level of developmental malformations and increased egg-larval mortality in herring. Eggs and larvae of some demersal and semidemersal fish also could suffer some increased mortality. Potential noise and disturbance effects to these fishery resources due to exploration and production in these areas also would be eliminated. The various effects to fisheries resources taken altogether are not expected to cause population-level changes.

d. __Effects on Marine and Coastal Birds__: The Coastal Fisheries Deferral Alternative would remove approximately 153 whole and partial blocks (32.77% of the sale area) from the proposed lease sale, leasing only those blocks in the central part of the planning area. This alternative would provide a buffer zone (3-18 mi wide) along the coasts of lower Cook Inlet, important habitats of marine and coastal birds. The chance of one or more oil spills ≥1,000 bbl occurring decreases from 27 percent in the base case to 19 percent in this alternative.

Leasing would be deferred from (1) an area on the western side of the Barren Islands, a major Gulf of Alaska seabird colony complex, and (2) coastal areas in lower Cook Inlet, including Chisik and Duck Islands, important Cook Inlet seabird colonies locations and important waterfowl- and shorebird-coastal habitats.

The buffer zone surrounding major wildlife-concentration areas in lower Cook Inlet could provide additional protection from oil spills for these habitats by eliminating potential platform-spill locations from the area. Based on the summer 30-day conditional risk contours, this alternative would eliminate platform-spill locations in lower Cook Inlet with an estimated >50-percent chance of contacting Chinitna Bay (ERA 2) and inner Kamishak Bay (ERA 5) (Appendix B, Figs. B-2, B-5). This alternative also would eliminate most potential platform-spill locations with a >25 and <50-percent chance of contacting the Barren Islands seabird-concentration area (ERA 6) (Appendix B, Fig. B-6).

A comparison of Alternative I and Alternative V combined probabilities (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting environmental resource areas important to marine and coastal birds is shown in Figure IV.B.5.d-1. Alternative V reduces the combined probabilities to 11 of the 15 environmental resource areas (including land in general) estimated under Alternative I. The highest reduction in chance of one or more ≥1,000-bbl-oil spills occurring and contacting are to land in general (reduced from 26 to 19%), outer Kamishak Bay (ERA 4, reduced from 8 to 6%), Tuxedni Bay (ERA 1, reduced from 7 to 5%), and outer Kamishak Bay (ERA 4, reduced from 8 to 6%). The reductions in combined probabilities to other environmental resource areas generally reflect the reduction in volume of oil assumed present in the alternative compared to the base case after the oil in the deferred tracts is subtracted.

Thus, some limited reduction of oil-spill risks on seabirds, sea ducks, and shorebirds and their habitats in outer Kamishak Bay, Tuxedni Bay, Kachemak Bay, and other nearshore habitats in lower Cook Inlet (ERA's 1, 4, 5, and land, respectively) are expected to occur under this alternative. However, the probabilities of occurrence and contact to other coastal habitats of marine and coastal birds in lower Cook Inlet still are high enough to expect that the assumed 50,000-bbl-oil spill would occur and contact at least one or more of the environmental resource areas—important habitats of marine and coastal birds; there still is a 19-percent chance of one or more ≥1,000-bbl spills occurring and contacting land-shoreline and affecting several thousand—to perhaps 100,000—birds (Fig. IV.B.5.d-1). If a tanker spill occurred at T4 in the Kennedy Entrance to Cook Inlet or in the Gulf of Alaska, the Barren Islands' seabird-colony-concentration area is estimated to be contacted by the spill, and several thousand seabirds are expected to be lost (Figs. IV.B.1.d-3 and 4, ERA 6). Thus, the potential oil-spill effects to the Barren Islands' seabird-colony complex and to other marine and coastal birds and their habitats in lower Cook Inlet are expected to remain about the same as for the Proposal.

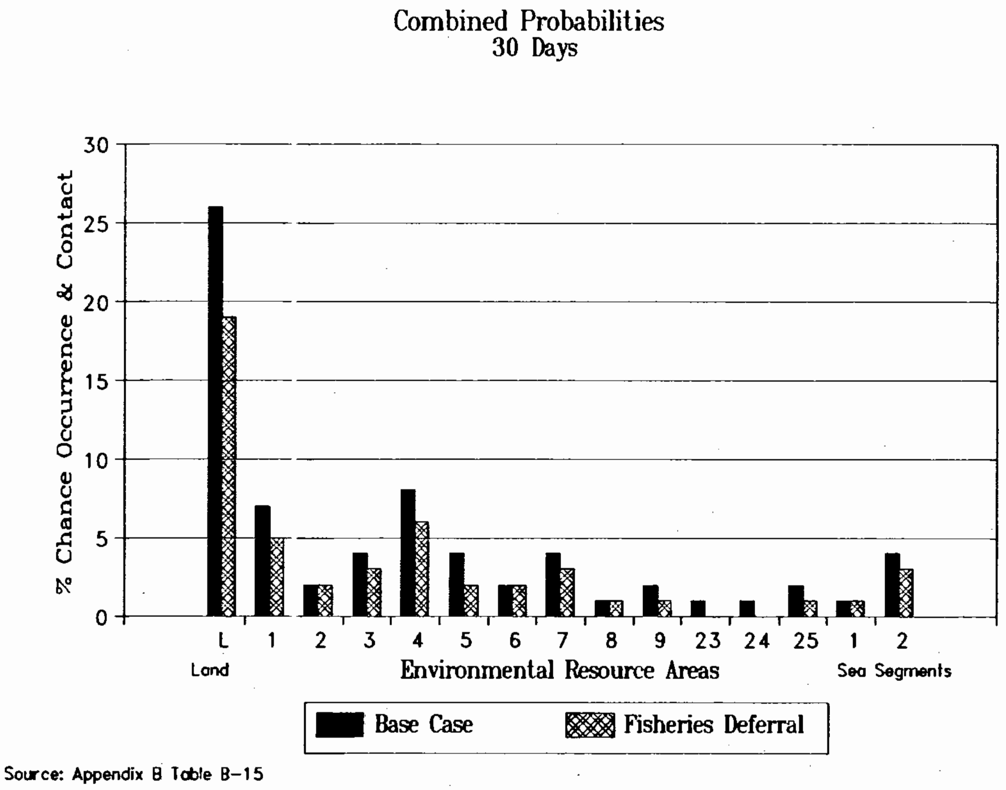
Noise and disturbance and habitat-alteration effects on marine and coastal birds are expected to be the same as described under the Alternative I base case, because the transportation scenario and levels of exploration and development activities for this alternative are expected to be the same as for the Proposal.

Conclusion: The overall effect of Alternative V on marine and coastal birds (the loss of several thousand—to perhaps 100,000—birds, with recovery taking >1 generation) is expected to be about the same as described under the base case. Oil-spill effects on bird populations potentially could be reduced locally in the Kamishak, Tuxedni, Chinitna, and Kachemak Bays.

e. Effects on Nonendangered Marine Mammals (Pinnipeds, Cetaceans, and the Sea Otter): This deferral alternative removes lease blocks from the sale area that are important to coastal fisheries. This reduces the probability of a spill from pipelines or platforms and reduces the amount of noise and disturbance in and around certain coastal fisheries resources and wildlife areas. In fact, more extensive wildlife buffer zones are created under this alternative than under the Wildlife Concentration Buffer Deferral (Alternative IV). The effect of this deferral alternative will be examined using 30-day conditional probabilities for the summer season on the most sensitive marine mammal resource areas in the sale area that could be affected under the base case. Effects on marine mammals due to (1) oil spills and oil pollution, (2) noise and disturbance, and (3) habitat loss and/or alteration have been analyzed and appear in full under the base case (Sec. IV.B.1.e).

Sale-specific oil-spill effects on marine mammal resources have been estimated using combined probabilities, conditional risk contours, and conditional probabilities for transportation segments generated from the OSRA model. Mortality rates derived from the EVOS and adjusted by the SF were used to estimate potentially lethal effects of an oil spill on each species. Sale-specific oil-spill effects were estimated to result in the mortality of <10 fur seals and killer whales, respectively; approximately 43 beluga whales; approximately 60 harbor seals; and between 75 to 100 sea otters. Recovery to prespill numbers was estimated to occur in about 1 to 2 years, with the exception of beluga whales, where recovery may require up to 7 years.

Effects to marine mammals due to noise and disturbance also were reviewed and estimated. The loudest noise source created by industry activity was identified as seismic noise. Sounds generated by seismic surveys probably would not affect harbor and fur seal and sea otter activities. Effects on the minke whale have not been studied but likely would be similar to effects on other baleen whales, which generally are tolerant of seismic pulses. Subtle behavioral changes may occur on occasion at low-sound levels, with stronger avoidance reactions when sound levels reach 160 to 170 dB, or higher. Toothed-whale hearing appears poor at frequencies lower than 1 kHz, where most industrial sounds and seismic pulses are produced, so they probably would be unaffected.



Source: Appendix B Table B-15

Figure IV.B.5.d-1. Combined Probabilities (expressed as percent chance) of One or More Spills ≥ 1,000 Barrels Occurring and Contacting Certain Environmental Resource Areas Within 30 Days Under the Base Case and Under Alternative V over the Assumed Production Life of the Sale 149 Area.

Aircraft overflights can be another potential source of disturbance. Pinniped response to low-altitude aircraft can result in stampede or flight into the water. This may increase pup mortality during the pupping season. Both baleen and toothed whales usually respond to low overflights by diving. Reactions of pinnipeds and cetaceans vary by aircraft type, altitude of flight, and circumstances of the animals. These disturbance reactions usually are short term, with seals reoccupying haulouts and whales continuing their activities usually within a matter of hours.

The effects of habitat alteration/degradation also were examined. These would be limited to temporary disturbance to some sea otters and harbor seals in the nearshore environment associated with construction of pipeline and transport facilities. This disturbance likely would be relatively short term and very localized and should not affect survival.

The Coastal Fisheries Deferral Alternative buffer zones are very effective in reducing risk to environmental resources in lower Cook Inlet. Based on the summer 30-day conditional risk contours, the risk of spills due to production are greatly reduced in Tuxedni Bay (ERA 1) and inner and outer Kamishak Bays (ERA's 5 and 4), where there is an estimated chance of contact as high as 95 percent (Appendix B, Figs. B-1, B-5, B-4). Most of the reduced risk in Tuxedni Bay and outer Kamishak Bay is in areas with a chance of contact >95 percent, while most of the area of reduced risk in inner Kamishak Bay is in areas where chance of contact is between 50 and 90 percent. There also is reduced risk in all three areas where the chance of contact ranges between 5 to 50 percent, though some chance of contact between 25 to 75 percent also is eliminated from Tuxedni Bay. Other areas in lower Cook Inlet with reduced risk because of the deferral are Chinitna Bay (ERA 2), Kachemak Bay (ERA 3), the Barren Islands, and Cape Douglas (ERA 7). Most of the reduced risk to these areas is in regions where the chance of contact is between 5 to 25 or 5 to 50 percent. This alternative reduces risk to sea otters, harbor seals, and beluga whales in Kamishak Bay; harbor seals and beluga whales in Tuxedni Bay; and sea otters, harbor seals, fur seals, and nonendangered cetaceans in Chinitna Bay, Kachemak Bay, the Barren Islands, and Cape Douglas.

In summary, the estimated spill effects under the coastal fisheries deferral would be unchanged from the base case with a potential mortality of <10 fur seals and killer whales, respectively; approximately 43 beluga whales; approximately 60 harbor seals; and between 75 to 100 sea otters. Recovery to prespill numbers was estimated to occur in about 1 to 2 years, with the exception of beluga whales, where recovery may require up to 7 years. The short-term, local effects of noise, disturbance, and habitat alteration would be lessened for the nearshore species in the deferral area. These include sea otters, harbor seals, foraging fur seals, and some nonendangered cetaceans.

<u>**Conclusion:**</u> Compared to the base case, the estimated oil-spill effects under this deferral alternative would be unchanged, with a potential mortality of <10 fur seals and killer whales, respectively; approximately 43 beluga whales; approximately 60 harbor seals; and between 75 to 100 sea otters. Recovery to prespill numbers was estimated to occur in about 1 to 2 years, with the exception of beluga whales, where recovery may require up to 7 years. Potential noise and disturbance effects to these marine mammals due to exploration and production in these areas also would be eliminated by the deferral alternative.

f. Effects on Endangered and Threatened Species: Alternative V (Coastal Fisheries Deferral) would provide a buffer extending between 6 and 18 mi offshore around most of lower Cook Inlet. However, only those deferred lease blocks in the southeastern sale area northwest of the Barren Islands and west of the Kenai Peninsula lie within a zone of probable seasonal occurrence of endangered whale species, and areas potentially used by foraging or rafting Steller sea lions occupying the major rookery or haulouts in the Barren Islands. Nevertheless, this alternative removes approximately 15 percent of the limited southern sale area within which, under Alternative I (Proposal, Sec. IV.B.1.f), a small proportion of these species' populations potentially could be exposed to routine exploration or development/production activities.

For these populations, the most likely sources of potentially adverse effects associated with routine activities are disturbance (including drilling operations, aircraft and vessel traffic, and seismic surveys), and release of drilling muds and cuttings. The buffer created by removing lease blocks from the sale area would be expected to reduce effects of activity somewhat in these areas as a result of the greater distance between potential platform sites and wildlife concentrations. However, as discussed for Alternative I, potential effects from routine activities already are likely to be minimal because of the expectation that travel routes of few whales or sea lions will intersect those of vessels or aircraft, or approach a platform, and that any interaction effects (e.g., travel-direction change, area avoidance) will last for less than an hour. Likewise, exposure of whales or sea lions, or their prey species, to any materials (e.g., muds and cuttings) released into the environment is expected to have minimal effects due to rapid dispersal of such materials to nontoxic concentrations in this oceanographically dynamic area.

The buffer created by removing these blocks from the sale area would reduce the overall estimated probability of one or more oil spills ≥ 1,000 bbl occurring from 27 percent under Alternative I to 19 percent (Table IV.A.2-2), due to the reduction in projected oil resource, and also would be expected to reduce potential effects some- what in the southern portion of lower Cook Inlet, the Barren Islands area, and northern Shelikof Strait as a result of the additional weathering and clean up that could occur as spilled oil moves through the greater distance between potential platform spill sites and wildlife concentrations. Specifically, deferral of blocks northwest of the Barren Islands (ERA 6) would eliminate some potential platform oil-spill sites from which there is at least a >25- and <50-percent chance of contact during summer after 30 days (Appendix B, Fig. B-6). While removal of the platform contribution to spill risk from these blocks is expected to reduce the risk of spill contact in this sea lion intensive-use area somewhat, the relation of pipeline and tanker routes to the area, and thus the risk from these sources, remains essentially unchanged from Alternative I: the conditional probability (expressed as percent chance) of spilled-oil contact ranges from 95 percent from tanker segment T4 (Appendix B, Table B-4) to <0.5 percent from more distant sites (T1), but from most potential spill sites it is <20 percent (Table B-4). The combined probability (expressed as percent chance) of one or more ≥ 1,000 bbl oil spills from these sources, or from a platform outside the buffer, occurring and contacting sea lion haulout areas along Shelikof Strait is reduced from ≤4 percent to ≤3 percent in the north half of the sale area and remains <0.5 percent in the south (Appendix B, Table B-14, B-15; Fig. IV. A.2-6), so the risk to sea lions in this area is expected to remain essentially as discussed under Alternative I: the potential loss of a few tens of individuals requiring at least one generation for recovery. This alternative would not reduce potential effects on wintering Steller's eiders from those discussed for Alternative I (2 generations required for recovery from oil-spill losses).

Deferral of blocks from the southeastern sale area may provide some limited relief from disturbance and possible contact with drilling muds and cuttings, and any oil spilled for the small numbers of endangered whales, and Steller sea lions, that transit or occupy the southeastern portion of the proposed sale area by removing potential platform sites and associated support activities farther from the Barren Islands' migration routes and foraging areas. Thus, potential effects under this alternative are expected to be reduced to a limited extent from those discussed under Alternative I, which include: (1) exposure of ≤1 percent of the North Pacific fin whale and 5 percent of humpback whale populations occurring in this area to disturbance, with individuals affected for an hour or less per incident; (2) similarly small numbers of whales exposed to an oil spill, with any effects sublethal and short term; (3) a tanker spill outside entrances to Cook Inlet/Shelikof Strait contacting larger numbers of whales east of Kodiak Island, but without the occurrence of any mortality; (4) <2 percent of the central Gulf of Alaska Steller sea lion population (5% of the potentially affected area population) exposed to potentially disturbing activities with no rookeries or haulouts likely to be disturbed; (5) an oil spill potentially contacting up to several hundred sea lions, but with adult mortality not exceeding a few tens of individuals (pups and juveniles expected to be more severely affected); (6) overall sea lion mortality of <100 individuals resulting from an oil spill, requiring a recovery period of at least one generation; (7) no endangered or threatened bird populations are expected to be affected by exploration or development/production activities; (8) wintering Steller's eiders experiencing oil-spill losses requiring two generations for recovery.

In summary, this alternative could result in the decreased potential for oil-spill contact of sea lions and endangered whales in southern lower Cook Inlet, the Barren Islands area, and northern Shelikof Strait as a result of the reduced oil resource projected and elimination of platforms from deferred southeastern blocks where these species are most likely to occur; however, such reduction is expected to be limited and local because of the already low probability of spill occurrence and contact in this area. Potentially disturbing activities and minor contaminants are expected to be reduced to minimal levels in these areas.

Conclusion: The overall effect of this alternative on endangered whales is expected to be somewhat less than the minimal effect discussed for Alternative I; likewise, effect on the Steller sea lion is expected to be somewhat reduced from the Alternative I determination that loss of a few tens of individuals from oil-spill effects could require a recovery period of at least one generation. Potential oil-spill effects on wintering Steller's eiders (recovery requiring 2 generations) are expected to remain the same as discussed for the Alternative I base case.

g. Effects on Terrestrial Mammals: This alternative would provide for a buffer zone for terrestrial mammal coastal habitats along the coasts of lower Cook Inlet. Leasing would be deferred in the following areas: (1) an area on the western side of the Barren Islands and (2) an area along the coast of lower Cook Inlet, including the southern part of the Kenai Peninsula, Alaska Peninsula-Chinitna Bay, Tuxedni Bay, and Ursus Cove containing brown bear spring-summer habitats along the shoreline and other important habitat of brown bears and other terrestrial mammals in lower Cook Inlet (Fig. II.E.1). The buffer zone surrounding important terrestrial mammal habitat areas in lower Cook Inlet could provide some protection from oil spills for these habitats by eliminating potential platform-spill locations from the immediate vicinity. The estimated chance of one or more oil spills ≥1,000 bbl occurring decreases from 27 percent under the base case to 19 percent under Alternative V.

A comparison of Alternative I and Alternative V combined probabilities (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting land segments representing coastal (shoreline) habitats of terrestrial mammals is shown in Figure IV.B.5.g-1. Alternative V reduces the combined probabilities of spill occurrence and contact to 9 of the 19 land segments estimated under Alternative I. The reduction in the probability of one or more ≥1,000-bbl spills occurring and contacting is shown for the following areas: Hallo Bay (LS 19), Cape Douglas (LS 22), Kamishak Bay (LS 25), Augustine Island (LS 27), Iniskin Bay north to near the Tuxedni Bay area on the Alaska Peninsula (LS's 29-31), the Nikishka area south to Kachemak Bay on the Kenai Peninsula (LS's 40-44), and the western Barren Islands (LS 47). These reductions in the probability of one or more ≥1,000-bbl spills occurring and contacting terrestrial mammal habitats reflect the protection provided by the buffer zone of deferred tracts under this alternative as well as the reduced volume of oil (reflected by the lower chance of spill occurrence) expected under this alternative compared to the base case.

This alternative also eliminates potential platform-spill sites that have a >25-percent estimated conditional probability (expressed as percent chance) of contacting Ursus Cove (Kamishak Bay area, LS 28), an important brown bear area (Appendix B, Fig. B-23), and eliminates potential platform-spill sites that have a >5-percent estimated conditional probability (expressed as percent chance) of contacting the Anchor Point area (Appendix B, Figs. B-26 through B-29) within 30 days during the summer.

Although the above reductions in combined probabilities of spill occurrence and contact and a reduction in platform oil-spill-estimated contact probabilities provides some protection to terrestrial mammal habitats along the coast of lower Cook Inlet, the conditional probabilities of contact remain the same for a potential pipeline or tanker spill contacting these coastal habitats of terrestrial mammals. Thus, some local reduction of oil-spill effects on brown bears, river otters, and other terrestrial mammals and their habitats along the coast of the Alaska Peninsula at Hallo, Iniskin, Chinitna, and Tuxedni Bays and the Nikishka area south to Kachemak Bay on the Kenai Peninsula is expected under this alternative. However, oil-spill risks and effects from the assumed tanker route in and out of Cook Inlet and oil-spill risks from the pipeline route are expected to remain unchanged. Thus, the potential overall oil-spill effects on terrestrial mammals are expected to remain about the same as described under the proposal (loss of <50 river otters, perhaps 100 deer, and 10 bears).

Noise and disturbance and habitat-alteration effects on terrestrial mammals are expected to be the same as described under the Alternative I base case (loss of <50 river otters, perhaps 100 deer, and 10 bears) of the proposal, with the same level of air and vessel traffic and the same onshore facilities to be constructed under both alternatives.

Conclusion: The overall effect of oil spills, noise and disturbance, and habitat alteration on terrestrial mammals is expected to be about the same as described under the base case (loss of <50 river otters, perhaps 100 deer, and 10 bears). Oil-spill effects on brown bears, river otters, and other terrestrial mammals are expected be reduced locally along the coasts of Hallo, Iniskin, Chinitna, and Tuxedni Bays and the Nikishka area south to Kachemak Bay on the Kenai Peninsula.

h. Effects on the Economy: Increased employment is the most significant economic effect generated by Alternative V, Coastal Fisheries Deferral. Employees would work on the construction, operation, and servicing of facilities associated with the sale. These facilities are described in the estimated and assumed scenario, Table II.A-1, and are outlined as follows: 2 exploration wells; 3 delineation wells; 2 production platforms; 29 production/ service oil wells; 1 shore base constructed; and 100 mi of offshore pipeline.

For Alternative V, direct OCS resident employment on the western side of the Kenai Peninsula would start with 179 in 1997; rise to 245 in 1998, to 694 in 1999 and 1,054 in 2000; drop to 425 in 2001; rise to 639 in the year 2002; and drop to 398 in 2003. The employment level varies between 398 and 412 from year 2004 through 2020.

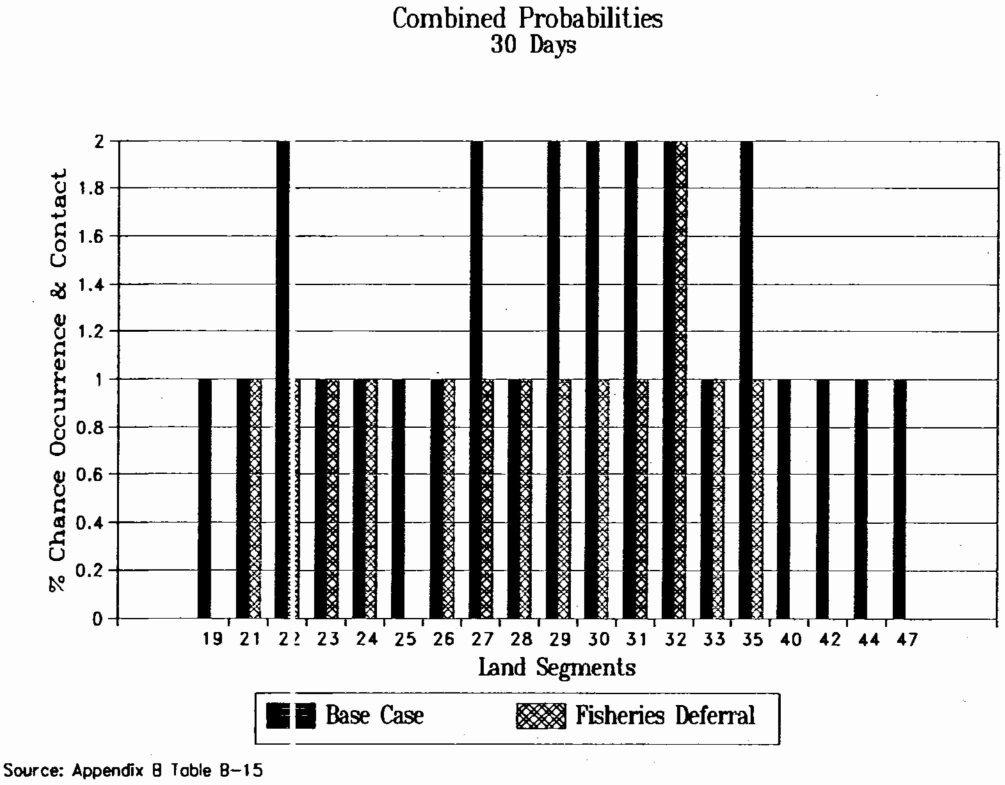


Figure IV.B.5.g-1. Combined Probabilities (expressed as percent chance) of One or More Spills ≥1,000 Barrels Occurring and Contacting Certain Land Segments Within 30 Days Under the Base Case and Under Alternative V Over the Assumed Production Life of Sale 149 Area.

Indirect resident employment is estimated to be 12.6 percent of direct OCS resident employment and would peak at 133 for the year 2000. (See Appendix G for a complete description of methodology for employment and population forecasts. Also see Section IV.B.1.h, Economy, for assumptions and general analytic methods used for this alternative.)

Resident employment on the western side of the Kenai Peninsula is estimated to be 15,986 for 1995 and is projected to rise 0.9 percent annually without the sale. Between the years 1997 and 2003, annual increases and decreases in OCS direct and indirect employment would be between 1 and 4 percent of total employment on the western Kenai Peninsula.

The OCS activity could generate effects on other facets of the economy including income, prices, and taxes. The OCS workers are likely to earn relatively high wages compared to the average income on the western part of the Kenai Peninsula. Even assuming that the income of the OCS workers was twice as high as the average for the western Kenai Peninsula, the effect on the average income would be to change it by <3 percent for <5 years. The reason for this is that the largest rise for 1 year in direct OCS employment is 449 workers in 1999 compared to resident employment of 16,422 in 1998.

Because of the relatively short period of time—6 years for the exploration and development phases—that housing would be needed for the large number of OCS workers, it is assumed that temporary housing would be provided by OCS lessees for over half of the OCS workers in these peak years. In the single peak year 2000, temporary housing would be provided for about 400 OCS workers.

Revenue from property tax would increase <2 percent for <5 years for the Kenai Peninsula Borough (KPB). The value of taxable improvements to property during a peak year is estimated to be $40 million (1993 dollars), which is 1.3 percent of the total taxable valuation for the KPB in 1993 (Barnes, 1993, personal comm.). Primary components of taxable improvements are as follows: improvements in existing facilities equivalent to a new shore base and new housing for workers. It is assumed that 100 permanent housing units would be built for the 4 years following exploration, 1999 to 2002. At an average value of $100,000 (1993 dollars) per housing unit, the average value of new housing per year would be $10 million (1993 dollars). The value of improvements to shore-base facilities is estimated to be $30 million (1993 dollars) for the peak year.

Annual property tax revenue of $1.7 million (1993 dollars) would accrue to the KPB and $0.4 million (1993 dollars) to the State after all major improvements are constructed or installed, which would be 2002. The improvements are estimated to be $100 million for shore-base improvements and $40 million for 400 new housing units. This total of $140 million of improvements at the rate of 12 mills results in property-tax revenue of $1.7 million. The mill rate of 12 is the approximate average of the mill rates for seven tax-code areas between Anchor Point and Nikiski; the mill rate accruing to the State of Alaska for oil facilities in this case is 8 (Alt, 1993, personal comm.). It is assumed that half of the shore-base improvements and all of the pipelines are oil facilities.

If the KPB had a sales tax during the period of OCS activity, the expenditures by direct OCS workers and indirect workers would translate to a maximum sales-tax revenue change of <4 percent for <5 years. This is because the sales-tax revenue would be in proportion to the increase in total income for all additional OCS workers in 1 year; and it is assumed that the income for OCS workers would be two times that of the average worker for the western Kenai Peninsula.

Headquarters employment is assumed to be located in Anchorage. It would rise from 10 in 1995 to 100 in 2003 to 200 from 2004 through 2012 and drop to 180 from 2013 through 2021. It would result in changes that are <1 percent of Anchorage employment in any given year.

The economic effects of oil spills <1,000 bbl would be very minimal. These small spills would be cleaned up by the CISPRI organization or some similar organization. A spill <1,000 bbl would require <50 person hours to clean up.

The most relevant historical experience in Alaskan waters to a tanker spill of 109,000 bbl (average tanker-size spill, see Sec. IV.A.2.a(4)) is the EVOS of 1989, which spilled 240,000 bbl. This spill generated enormous employment that rose to the level of 10,000 workers directly doing cleanup work in relatively remote locations. Smaller and smaller numbers of cleanup workers returned in the warmer months each year following 1989 until

1992. Numerous local residents quit their jobs to work on the cleanup at often significantly higher wages. This generated a sudden and significant inflation in the local economy (Cohen, 1993). Anecdotal information indicates that housing rents in Valdez in 1989 increased from 25 percent in some cases to sixfold in others, and inflated rents continued into 1990. Prices of food and other goods increased only slightly, because people could drive to Anchorage to purchase them (Henning, 1993, personal comm.). Research shows that no data on inflation were gathered in a systematic way during the EVOS, although most observers agree that there was temporary inflation.

The number of cleanup workers actually used for a spill associated with Sale 149 would depend to a great extent on what procedures are called for in the oil-spill-contingency plan, how well prepared with equipment and training the entities responsible for cleanup are, how efficiently the cleanup is executed, and how well in reality the coordination of cleanup is executed among numerous responsible entities. A spill resulting from activity associated with Sale 149 could generate half the workers associated with the EVOS, or 5,000 cleanup workers. The probability of a ≥1,000-bbl oil spill occurring and contacting land would be 19 percent. Housing rents in the western Kenai Peninsula probably would double for 1 year following a major spill.

Conclusion: Alternative V would generate changes slightly less than the base case. These changes would be 1 and 4 percent in resident employment, <3 percent in average income, <3 percent in cost of living, <2 percent in property tax, and <4 percent in sales taxes on the western side of the Kenai Peninsula annually for <5 years. Property-tax revenue of $1.7 million for the KPB and $0.4 million for the State (in 1993 dollars) would be added annually after the year 2002.

A large oil spill would generate 5,000 cleanup jobs for 6 months in the first year, declining to zero by the fourth year following the spill. Local communities would experience a doubling of housing rents for 1 year.

i. Effects on Commercial Fisheries: Activities associated with the Coastal Fisheries Deferral Alternative (Alternative V) that may affect the Cook Inlet commercial-fishing industry include drilling discharges, offshore construction, seismic surveys, and oil spills. The effect of these activities on the Cook Inlet commercial-fishing industry are discussed in the base case (Sec. IV.B.1.i) and are summarized below. The following analysis for Alternative V focuses on the differences in the amount of activity (the only variable) estimated for Alternative V, as compared to that of the base case. It then estimates the resulting effect of this difference on the Cook Inlet commercial-fishing industry for Alternative V.

This alternative would delete 153 partial and whole blocks, or about 33 percent of the sale area discussed in the base case. This eliminates any OCS activity in the deferral areas and would eliminate them as areas where a platform oil spill could originate. The probability of a platform spill occurring is estimated to be 8 percent compared to 12 percent for the base case. However, platforms outside the deferral areas still would be a potential oil-spill source that could affect the deferral areas. Also, the probability of one or more oil spills occurring from a tanker or pipeline for the deferral areas would be only slightly less (2% and 4%, respectively) than the base case. Hence, in terms of an oil spill, the only difference between this alternative and the base case is the extra time it would take for a platform (now outside of the deferral areas for Alternative V) spill to reach the deferral areas. While this extra time likely would reduce the toxicity of the oil entering the deferral areas, it likely would not reduce the severity of economic losses to the commercial-fishing industry due to closures. For these reasons, the effects of Alternative V on the commercial-fishing industry are expected to be essentially the same as discussed for the base case; they are summarized below.

Drilling discharges associated with the base case are not expected to have an effect on commercial fishing due to the limited area affected near the platform-discharge point. Offshore construction, platforms, and pipelines are expected to result in some space-use conflicts (e.g., competition for docking space or gear loss); however, these are expected to be few in number and minor in scope. Seismic surveys, planned and coordinated with the commercial-fishing industry, are expected to have a minimal effect on the Cook Inlet commercial-fishing industry. Due to the relatively small amount of oil involved (325 bbl), the 34 small oil spills (Table IV.A.2-4d) assumed for the Coastal Fisheries Deferral Alternative are not expected to result in closures or reduced market values over the life of the proposal. Hence, they are not expected to have a measurable economic effect on the Cook Inlet commercial- fishing industry. However, the assumed large (50,000-bbl) base-case oil spill is expected to affect pot, longline, trawl, drift-gillnet, and set-gillnet fisheries in Cook Inlet.

The estimated economic effect of the base-case oil spill on the Cook Inlet commercial-fishing industry is based on what occurred during the EVOS and GBOS, and primarily depends on the highly variable EVOS cost estimates (ranging from $9-43 million/year for 2 years). From 1983 to 1993, the value of the Cook Inlet commercial fishery appears to have ranged between about $50 and $135 million/year. Based on the above, in any 2-year period when the value of the Cook Inlet commercial fishery is estimated to be about $50 million/year, a 2-year loss of about $9 million/year represents an 18-percent/year loss for 2 years; whereas a 2-year loss of about $43 million/year represents an 86-percent/year loss for 2 years. In a 2-year period when the value of the Cook Inlet commercial fishery is estimated to be closer to $135 million/year, a 2-year loss of about $9 million/year represents a 7-percent/year loss for 2 years; whereas a 2-year loss of $43 million/year represents a 32-percent/year loss for 2 years. Because the occurrence of a large oil spill would preclude any knowledge of what the commercial fishery would have been worth, the value of the commercial fishery at the time of the assumed 50,000-bbl-oil spill is assumed to be the average annual value (1983-1993) of the Cook Inlet commercial fishery. Thus, in terms of the average annual value of the Cook Inlet commercial fishery (about $65 million), the assumed base-case oil spill is estimated to result in an economic loss of about 15 to 65 percent/year for 2 years. Estimated losses to the Kodiak commercial-fishing industry are expected to be less than half of those estimated for Cook Inlet, or about 5 to 25 percent/year for 2 years following the assumed 50,000-bbl Cook Inlet oil spill. This amounts to an estimated loss of about $4 to $19 million/year to the Kodiak commercial-fishing industry However, the EVOS experience has demonstrated that compensation to the commercial-fishing industry for participating in the cleanup of a large Cook Inlet oil spill is likely to exceed these economic losses by several orders of magnitude.

Conclusion: Based on the assumptions discussed in the text (e.g., a 50,000-bbl spill occurs during the commercial-fishing season), EVOS-loss estimates, and the average annual value of the Cook Inlet and Kodiak commercial fisheries, the Coastal Fisheries Deferral Alternative is estimated to result in economic losses to the Cook Inlet commercial-fishing industry ranging from about 15 to 65 percent/year for 2 years following the assumed 50,000-bbl-oil spill. Losses to the Kodiak commercial-fishing industry from the same spill are estimated to range from about 5 to 25 percent year for two years following the spill. The chance of one or more oil spills ≥1,000 bbl is estimated to be 19 percent.

j. Effects on Subsistence-Harvest Patterns: The effects-producing factors for Alternative V, the Coastal Fisheries Deferral Alternative, are the same as for the base case, including routine operations such as seismic surveys, the disposal of drilling muds and cuttings, and the operation of support facilities, as well as accidental events such as oil spills.

Geographically, Alternative V defers a substantial number of blocks along the western and eastern sides of the proposed sale area, thus withdrawing the location of the blocks proposed for lease further from the shore or island groups. Deferral of these blocks could reduce effects on coastal commercial fisheries and reduce the potential for effects on subsistence harvests in southern Kenai Peninsula communities as well as Nanwalek and Port Graham, although potential effects on these communities would be attributable moreso to facility operations and transportation considerations than proximity to leased blocks.

Besides geographic considerations, Alternative V differs from the base case in the reduction of exploration and delineation wells drilled from 8 to 5, reduction in the number of production platforms used from 3 to 2, reduction in the number of production wells drilled from 48 to 29, and reduction in the amount of oil production from 200 MMbbl to 140 MMbbl. Reduced effects on subsistence resources could occur from reducing the number of exploratory and production wells drilled through factors such as the discharge of reduced amounts of drilling muds and cuttings and reduced numbers of helicopter and vessel trips in comparison with the base case, although such reductions may not produce measurable effects reductions. Otherwise, the number and location of pipeline landfalls; the number and location of shore bases; and the number of exploration, delineation, and production rigs in operation per year are the same as the base case. Effects on subsistence-harvest patterns from operating these facilities would be the same as in the base case.

Effects on subsistence-harvest patterns from oil-spill events essentially would be the same as the base case in that the production and transportation scenarios are the same as the base case. There is a 7-percent reduction (19% vs. 26% in the base case) in the chance of one or more oil spills ≥1,000 bbl occurring and contacting land within 30 days, and most of the contacts with land segments occur on the west side of Cook Inlet, relatively removed from subsistence-harvest areas.

communities could experience subsistence-resource loss, primarily because of the high level of exposure to spills from transportation sources, should they occur. Such losses could include the lack of resource availability, accessibility, or desirability for use. Reductions in subsistence-harvest levels for specific resources could extend for a year or more. Elsewhere in Cook Inlet and on Kodiak Island and the Alaska Peninsula, effects on subsistence-harvest patterns are estimated to be limited in magnitude and duration and not of such a nature as to cause measurable changes in the availability, accessibility, or desirability of most subsistence resources.

Conclusion: Effects on subsistence-harvest patterns are expected essentially to be the same as Alternative I (base case), in that subsistence harvests would be reduced or substantially altered by as much as 50 percent in one or more southern Kenai Peninsula communities for at least 1 year and, to a lesser extent, for selected subsistence resources 2 to 3 years beyond. However, deferral of a substantial number of blocks near shoreline or island groups could reduce the potential for effects on subsistence harvests to some extent.

k. Effects on Sociocultural Systems: The effect-producing factors for Alternative V, the Coastal Fisheries Deferral Alternative, include prelease and postlease planning processes, the introduction of industrial activities and changes in community population and/or employment levels, potential effects on subsistence-harvest patterns, and effects from accidental oil spills and cleanup efforts.

Effects on sociocultural systems begin with the prelease processes of announcing the proposed sale and carrying out the preparation of an EIS. Given a significant oil discovery, planning processes are again engaged to prepare a developmental EIS. Each of these sometimes lengthy processes cause stress and anxiety among affected publics, although the stakes would be different. The discussion under the base case (Sec. IV.B.1.k) explores the types of impacts involved.

The Coastal Fisheries Deferral Alternative has the same technical characteristics as the base case regarding the number and location of pipeline landfalls, the number and location of shore bases, and the number of exploration, delineation, and production rigs in operation per year. It differs from the base case in the number of exploration and delineation wells drilled (reduced from 8-5), the number of production platforms used (reduced from 3-2), the number of production wells drilled (from 48-29), and the amount of oil produced (from 200-140 MMbbl).

As discussed for the base case, it is more likely that the population associated with OCS-related industrial activities would be distributed within the central Kenai Peninsula area than according with the distribution of population established in the 1990 census of population. Accordingly, Table IV.B.5.k-1 shows this distribution to represent a percentage of increase in population for the mid-Peninsula area of about half that of the base case in the long-term and about the same as the base case in the years 1999 and 2000. Consequently, effects on sociocultural systems from population increases should be generally the same as for the base case in that the effects on social and cultural institutions in this area of the Kenai Peninsula from population increase are even less than those imposed under the base case.

Effects on subsistence-harvest patterns from oil-spill events would be the same as the base case in that the number of spills estimated to occur and the production and transportation scenarios would be the same as or similar to the base case. Likewise, effects from oil-spill and cleanup events would be the same as for the base case.

As a consequence of the above, effects on sociocultural systems in Alternative V would be centered on the Kenai Peninsula, including the Alutiiq communities of Nanwalek and Port Graham. Resident population associated with the sale would do little to change existing sociocultural systems in the central Kenai Peninsula area, where new resident population would be expected to live. Despite the limited chance (1%) that one or more oil spills ≥1,000 bbl would occur and contact land, the individual, social, and institutional effects from these and tanker spills, should they occur, could be serious. Individual and social stress and anxiety levels would be expected to increase in southern Kenai Peninsula communities over the loss of subsistence resources, contamination of habitat, fear of the health effects of eating contaminated wild foods, and the need to depend on the knowledge of others about environmental contamination. In the Alutiiq communities, the organization of subsistence activities among kinship and friendship groups and the relationships among those that customarily process and share subsistence harvests also could be modified or could decline in importance. Stress-induced increases in alcohol and drug abuse would produce increases in numerous substance-abuse problems, such as child abuse, domestic violence, and accidents. The duration of individual and social effects would depend on the severity of the oil-spill experience.

Table IV.B.5.k-1
Alternative Distribution of Sale-Related Resident Population within the Kenai Peninsula Borough (KPB): Mid-Peninsula Area; Alternative V

Year	Mid-Peninsula Total Resident Population without Sale	Sale-Related Resident Population	Mid-Peninsula Resident Population with Sale	Mid-Peninsula Percentage of Increase
1997	19,848	491	20,339	2.4
1998	20,027	673	20,700	3.3
1999	20,207	1,906	22,113	8.6
2000	20,389	2,895	23,284	12.4
2001	20,572	1,167	21,739	5.4
2002	20,757	1,755	22,512	7.8
2003	20,944	1,093	22,037	5.0
2004	21,133	1,107	22,240	5.0
2005	21,323	1,093	22,416	4.9
2006	21,515	1,093	22,608	4.8
2007	21,708	1,093	22,801	4.8
2008	21,904	1,093	22,997	4.8
2009	22,101	1,107	23,208	4.8
2010	22,300	1,132	23,432	4.8
2011	22,501	1,131	23,632	4.8
2012	22,703	1,093	23,796	4.6
2013	22,907	1,093	24,000	4.6
2014	23,114	1,093	24,207	4.5
2015	23,322	1,093	24,415	4.5
2016	23,531	1,094	24,625	4.4
2017	23,743	1,093	24,836	4.4
2018	23,957	1,093	25,050	4.4
2019	24,173	1,093	25,266	4.3
2020	24,390	1,093	25,483	4.3

Source: MMS, Alaska OCS Region.

Institutionally, communities would undergo considerable disruption and community conflict, with litigation constituting a secondary source of postspill social and community stress.

Conclusion: Effects on sociocultural systems are expected essentially to be the same as Alternative I (base case), in that one or more southern Kenai Peninsula communities would undergo periodic episodes of increased individual, social, and institutional stress and disruption that would last for several years in each instance and endure in memory for decades; effects are caused by both prelease and potential postlease processes and events. However, deferral of a substantial number of blocks near shoreline and island groups should reduce stress and anxiety to some extent.

l. Effects on Archaeological and Cultural Resources: Alternative V (Coastal Fisheries Deferral Alternative) should reduce effects on archaeological and cultural resources located in the deferral area, because it would lower the possibility of interaction from workers or the chance of contact from spilled oil. The activities associated with the discovery and production of oil included in the base case would be the same for this alternative but based on assumed resources of 140 MMbbl of oil. For Alternative V, the effects of an oil spill would not be lowered because the risk of contact from tanker and pipeline segments and, therefore, the risk of effect would not be removed for LS's 68 through 74, LS's 15 through 22, and LS's 32 through 36. An estimated 150 sites are in that area, and disturbance would be <3 percent, <5 sites, the same as for the base case for the above-mentioned land segments (see Sec. IV.B.1.1).

Conclusion: It is estimated that this alternative would not result in a lowering of the effect of the base case. Less than 3 percent of the archaeological sites and shipwrecks (an estimated 5 sites) on the shore and within the State's 3-mi zone would be affected.

m. Effects on National and State Parks and Related Recreational Places: The field-development and infrastructure-construction activities associated with this alternative's assumed resources of 140 MMbbl of oil would result in effects not substantively different from those of the base case in that effects due to area use by additional population and related infrastructure engendered by this alternative would be similar to those of the base case. Also for Alternative V, the effects of an oil spill would not be lowered because the chance of contact from tanker and pipeline segments and, therefore, the risk of effect, would not be removed for LS's 68 through 74, LS's 15 through 22, and LS's 32 through 36. The chance of contact and wear and tear from visitors and vandalism of the shore and intertidal zone habitats would be the same as in the base case.

Conclusion: It is estimated that this alternative would not result in a lowering of the population, infrastructure, or oil-spill-related effects of the base case. Less than 3 percent of the national and State parks and related recreational places would be affected for a period <3 years.

n. Effects on Air Quality: Air-quality regulations and procedures are discussed in Section IV.B.1.n, the base case. That discussion also describes the methodology used to model the air-quality effects associated with this proposed lease sale. The USEPA-approved OCD model was used to calculate the effects of pollutant emissions due to the proposal on onshore air quality. Because the Class I PSD areas allow for the least amount of degradation, the modeling scenario (i.e., source location) chosen for this analysis is the one that results in the maximum potential effect to the air quality of the designated national wilderness area of the Tuxedni National Wildlife Refuge, the only Class I area adjacent to the proposed sale area. The maximum-potential effect at any location in the Class II area would be the same. In all likelihood, effects to the Tuxedni National Wilderness Area would be lower than those calculated by the model.

For Alternative V, peak-year emissions from exploration would be from drilling one to two exploration wells and two to three delineation well from one rig. Peak-year emissions from development would include platform and pipeline installation and the drilling of 20 production wells from two rigs. Peak-year production emissions would result from operations (producing 13 MMbbl of oil) and transportation. Table IV.B.1.n-1 lists estimated uncontrolled pollutant emissions for the peak-exploration, peak-development, and peak-production years. Due to the configuration of the deferral area, the sale area would be 13 km (8 mi) off of Chisik Island (within the national wilderness area of the Tuxedni National Wildlife Refuge, the only Class I area adjacent to the sale area). This is significant because the air-quality modeling assumed maximum effect to the air quality of the national wilderness area. Alternative V provides a greater distance between the Class I area and the proposed action, thus reducing the already assessed minimal effect to air quality from the Alternative I base case.

Under the Federal and State of Alaska PSD regulations, because the estimated annual uncontrolled NO_2 emissions for peak-development year would exceed 250 tons per year, the lessee would be required to control NO_2 emissions through application of BACT to emissions sources to reduce NO_2 emissions (Table IV.B.1.n-2). The air-quality analysis performed using the OCD model for air pollutants emitted for exploration, development, and production under Alternative V showed that the maximum NO_2 concentration, averaged over a year, would be 0.19, 0.51, and 0.14 $\mu g/m^3$, respectively, at the shoreline; 7.6, 20.4, and 5.6 percent, respectively, of the available Class I increment for NO_2; and .76, 2.04, and .56 percent, respectively, for Class II. (Other pollutants also were modeled; however, NO_2 had the highest concentrations, which were well within PSD increments and air-quality standards.) The existing air quality would be maintained by a large margin.

For a more detailed discussion of the potential effects of air pollution—other than those effects addressed by standards—see Section IV.B.1.n. The amount of air pollutants reaching the shore is expected to be very low spatially and temporally because of the small amount of emissions from exploration, development, and production activities and their distance from shore. In addition, the probability of experiencing one or more blowouts in drilling the 29 wells projected for Alternative V would be 8 to 11 percent. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore due to exploration and development/production or accidental emissions would not be sufficient to harm vegetation. A light, short-term coating of soot over a localized area could result from oil fires. Consequently, the effects of air-pollutant emissions under Alternative V are expected to be minimal.

Conclusion: The effects associated with this alternative essentially would be the same, qualitatively, as those discussed for the Alternative I base case. Alternative V provides reduction in air-quality effects to onshore resources due to the deferral of areas nearshore from potential exploration, development, and production activities. Effects on onshore air quality analyzed for Alternative V are expected to be 20.4 percent of the maximum allowable PSD Class I increments. Only the Tuxedni National Wilderness Area is designated Class I, with the remaining area in and adjacent to the sale area designated Class II. Therefore, the potential effects would be much less. These effects would not make the concentrations of criteria pollutants in the onshore ambient air approach the air-quality standards. Consequently, a minimal effect on air quality with respect to standards is expected. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore from exploration, development, and production activities, and accidental emissions would not be sufficient to harm vegetation. A light, short-term coating of soot over a localized area could result from offshore oil fires.

o. Effects on Coastal Zone Management: Conclusions for biological resources in Section IV.B.5 indicate that this alternative, the Coastal Fisheries Deferral, could provide localized reduction in oil-spill risk for important coastal habitats in Cook Inlet and northern Shelikof Strait. Effects on subsistence are not expected to be reduced significantly. Statewide standards and associated district policies assessed in the base case include coastal development; geophysical-hazard areas; recreation; energy facilities; transportation and utilities; fish and seafood processing; subsistence; habitats; air, land, and water quality; and historic, prehistoric, and archaeological resources. Potential conflict with many of these Statewide standards and the associated district policies is unknown until a specific plan is submitted. However, a potential for conflict with the Statewide habitat standard was identified in the base case. Conflict resulted from the effects of seismic activities and oil spills in the offshore environment on commercial fishing. The ACMP provides a format for mitigating these potential conflicts; MMS operating procedures and the mitigating measures associated with this sale, especially the ITL clauses for Oil-Spill-Contingency Response, Bird and Marine Mammal Protection, Sensitive Areas to be Considered in Oil-Spill-Contingency Plans, Coastal Zone Management, and the stipulations on Density Restrictions Related to Commercial Fishing Uses, and Minimizing Potential Conflicts Between Oil and Gas Industry and Fishing Activities, provide additional mechanisms to ensure that activities that may follow this sale avoid conflict with the ACMP.

Conclusion: Potential conflict with the Statewide standard on habitats is possible. Site-specific information is necessary to ensure there is no conflict with the policies related to coastal development; geophysical hazards; energy-facility siting; transportation and utilities; subsistence; air, land, and water quality; and historic, prehistoric, and archaeological resources. Conflict is not inherent in the scenario.

6. Alternative VI, Pollock-Spawning Area Deferral Alternative:

Description of Alternative VI: The Pollock-Spawning Area Deferral Alternative would offer for leasing 361 blocks—approximately 1.79 million acres—which constitutes 90.4 percent of the proposed sale area. This alternative would offer for deferral 42 blocks (189,864 acres) located in the far south of the proposed sale area (Fig. II.E.1). Deleting the blocks in Shelikof Strait would address concerns expressed regarding the protection of pollock spawning areas for habitat disturbance and/or alteration.

Resource Estimates and Basic Exploration, Development, and Production Transportation Assumption: The resources forecast for this alternative are assumed to be 150 MMbbl, approximately 25 percent less than Alternative I. Accordingly, resource exploration and development activity also would be somewhat less than the Proposal. Reviewing Table II.A.1, Alternative VI has 1 fewer exploration-period well (7), 8 fewer development wells (40), and only 95 mi of subsea pipeline, as compared to 125 mi for Alternative I. Most other exploration, production, and transportation assumptions, including number of production platforms, developmental timeframes, field life, and facility locations as discussed in the base-case scenario of the proposed action, virtually are the same for this alternative. See Table IV.A.1.

Probability of One or More Spills Greater than or Equal to 1,000 Barrels Occurring: For this deferral alternative, there is a 21-percent probability of one or more spills ≥1,000 bbl occurring as compared to 27 percent for Alterative I (base case) (Table IV.A.2-2). The probability of one or more spills ≥1,000 bbl from (1) platforms is 9 percent, (2) pipelines is 10 percent, and (3) tankers is 4 percent compared to 12, 13, and 6 percent, respectively, for the Alternative I (base case) (Appendix B, Table B-1).

a. **Effects on Water Quality:** For Alternative VI, the activities associated with petroleum exploitation most likely to affect water quality in the CI/SS sale area are (1) the permitted discharges from exploration-drilling units and production platforms, (2) accidental oil spills, and (3) construction activities. Selecting the Pollock-Spawning Area Deferral Alternative would reduce the economically recoverable oil resources assumed for analysis from 200 MMbbl (Alternative I base case) to an assumed 150 MMbbl. The types of activities associated with exploiting the potential oil resources of this alternative are the same as for Alternative I (base case), but the level of activities are reduced; Table II.A.1. The types and levels of activities include the number of wells drilled and quantities of muds and cuttings discharged, the number of production platforms and the types and quantities of discharges, the number of pipeline miles, and the number of oil spills and the amount spilled (Tables II.A.1, IV.A.2-2, and IV.A.2-4). The characteristics of the discharges, spills, and activities and their potential effects on water quality are described in Section IV.B.1.a and summarized in this section.

The benefits of the deferral alternative are derived from (1) a reduced level of drilling and production activities associated with the exploration for and production of an assumed 150 MMbbl of oil and (2) the exclusion of exploration-drilling units and production platforms from locating in the deferred areas—about 10 percent of the Sale 149 Call area; these areas are shown in Figure II.E.1. Compared to Alternative I (base case), the reduced level of drilling and production activities would result in a decrease in the amount of material discharged into the waters of Cook Inlet. Based on information from Table IV.B.1.a-2, the discharges would be reduced by about (1) 4 to 22 percent for the drilling muds, (2) 16 percent for the cuttings, and (3) 25 percent for the produced waters. Excluding the drilling units and production platforms from the deferred areas eliminates the direct release of the permitted discharges into the waters of these areas.

The hydrodynamic processes in the Cook Inlet Planning Area suggest the water column generally is well mixed, and dilution would reduce the concentration of the substances in the discharges. Degradation processes also act to continuously reduce the concentrations of many substances deliberately or accidentally released into the environment.

Of the permitted discharges, drilling muds and cuttings and produced waters are the most significant discharges associated with offshore operations. The permitted discharges would add substances that may be foreign to or increase the concentration of constituents already present in the water column of CI/SS. This analysis will consider (1) the chronic criterion (for the protection of marine life) for SPM/turbidity to range from 100 to 1,000 mg/l (Sec. IV.B.1.a(1)(a)1)), (2) 15 μg/l to be the chronic criterion (for the protection of marine life) and 1,500 μg/l—a hundredfold higher level—to be the acute criterion for total hydrocarbons (Sec. IV.B.1.a(1)(b)2)a)), and (3) 10 μg/l to be the chronic criterion (for the protection of marine life) and 1,000 μg/l to be the acute criterion for TAH

(Sec. IV.B.1.a(1)(b)2)a)). In general, the added substances may cause sublethal effects in some marine organisms if concentrations are greater than the chronic criteria and lethal effects if concentrations are greater than acute criteria.

Drilling of the 3 exploration, 4 delineation, and 40 production and service wells could result in the discharge of an estimated 5,720 to 17,320 tons (dry weight) of drilling-mud components and 25,480 tons (dry weight) of cuttings (Table IV.B.1.a-2). The concentrations of discharged drilling muds initially may range from about 1,000 to 2,000 g/l and are expected to be greater than the SPM turbidity chronic criteria, 100 to 1,000 mg/l, assumed for this analysis. However, within about 100 to 200 m of the discharge point, mixing in the water column would reduce the concentrations by a factor of 10,000 to 1,000,000; the diluted concentrations are estimated to range from 1 to 200 mg/l. The concentration of suspended particulate matter in lower Cook Inlet and Shelikof Strait ranges from about 1 to 50 mg/l. Most of the solids in the discharges settle rapidly to the seafloor, where bottom currents disperse the finer particles. The drilling discharges are expected to take place over a 5- or 6-year period; most of the discharges would occur in the last 3 years and be associated with the drilling of the production and service wells.

Produced waters constitute the largest source of substances discharged into the marine environment, and their discharge is an issue of significant concern because of the types and amounts of naturally occurring substances they may carry and the manmade substances that may be added. The amount of produced water that would be discharged as a consequence of producing an assumed 150 MMbbl of oil in 19 years is estimated to range from about 14 to 111 MMbbl, or more (Table IV.B.1.a-2). The toxicity of produced waters mainly is caused by hydrocarbons that include nonvolatile hydrocarbons (EPA oil and grease) and aromatic hydrocarbons. The discharges associated with production activities are expected to last for the life of the field(s), at least 19 years, and the rates increase with time. The concentrations of nonvolatile hydrocarbons and TAH in the produced waters are estimated to range from 19 to 36 mg/l (19,000-36,000 μg/l) and 8 to 13 mg/l (8,000-13,000 μg/l), respectively.

The dilution rates for the produced waters are estimated to range from about 1,000:1 to 1,000,000 within several hundred meters of the discharge site. If dilutions are based on a rate of 1,000:1, the concentrations of nonvolatile hydrocarbons (oil and grease) within several hundred meters of the platform might range from 19 to 36 μg/l and the concentrations of TAH might range from 8 to 13 μg/l. These concentrations are well below the acute criteria of 1,500 μg/l for the nonvolatile hydrocarbons and 1,000 μg/l for the TAH that were assumed for this analysis but, in general, slightly greater than the chronic criteria of 15 μg/l for the nonvolatile hydrocarbons and 10 μg/l for the TAH. If dilution rates are about 10,000:1, the concentrations of nonvolatile hydrocarbons might range from about 2 to about 4 μg/l and the concentrations of TAH might be about 1 μg/l; these concentrations are less than the respective chronic criteria assumed for analysis. When discharged, the toxicity of the produced waters is expected to range from slightly toxic to practically nontoxic and will decrease with continued mixing in the water column.

The characteristics of the other constituents of the produced waters or other production-related discharges are expected to be within the USEPA criterion and/or be diluted in the water column within an area <2 km^2 to background concentrations or levels that would not cause sublethal to lethal effects in marine organisms.

The potential effects in any of the areas where there are permitted discharges would last for about (1) 2 to 3 months for each exploration well drilled and (2) 22 years for development and production activities. Future procedures and technologies of treating and handling drilling muds and cuttings and produced waters may reduce or eliminate the amounts discharged.

Accidental oil spills introduce into the water column a variety of hydrocarbon compounds whose concentrations may cause sublethal to lethal effects in marine organisms. Hydrodynamic and meteorological forces increase the areal extent of the spill and physical, chemical, and microbiological forces degrade the oil and reduce its concentration and toxicity.

The number of small ($<1,000$-bbl) accidental oil spills that might occur if oil is produced is estimated to be 37; the total volume of oil spilled is estimated to be 495 bbl (35 spills that average 5 bbl in size and two 160-bbl spills) (Table IV.A.2-4b and 4c). At the end of 3 days assuming no cleanup, the oil from a small spill may be dispersed in a 1- to 10-km^2 area in concentrations of about 20 to 61 μg/l. The concentration of the dispersed oil 10 days after a spill is estimated to be between 3 and 14 μg/l in an area of about 9 to 48 km^2 and, after 30 days, <1 to about 1 μg/l in an area of 34 to 199 km^2. During the 3- to 30-day interval following a small spill, the concentration of oil in the water column is not expected to exceed the total hydrocarbon acute criterion, 1,500 μg/l, assumed for this analysis; however, the concentration of spilled oil is expected to exceed the assumed total hydrocarbon chronic criterion, 15 μg/l, for several days to weeks.

There is an estimated 21-percent chance that one or more spills ≥1,000 would occur but, if it did, the size of the spill is estimated to be about 50,000 bbl (Table IV.A.2-2). For a summer spill, the concentration of total hydrocarbons in the water column from a large spill is not expected to exceed the chronic criterion (1,500 μg/l), at least after 3 days, but may exceed the acute criterion (15 μg/l) for >30 days. In the summer at the end of 3 days assuming no cleanup, the oil from a large spill may be dispersed in a 190-km^2 area in concentrations of about 711 μg/l. The concentration of the dispersed oil 10 days after a spill is estimated to be about 163 μg/l in an area of about 912 km^2 and, after 30 days, 21 μg/l in an area of about 3,715 km^2.

If the spill occurred in the winter, the size of the affected areas after the 3-, 10-, and 30-day time intervals would be less than for a summer spill but the concentration of oil in the water column would be greater. The oil in the water column is not expected to exceed the total hydrocarbon acute criterion (1,500 μg/l) during the (1) 3- to 30-day interval following a large spill under open-water conditions and (2) 10- to 30-day interval after a large spill in broken ice. During the 3- to 10-day interval following a large spill, the oil in the water column is expected to exceed the total hydrocarbon acute criterion (1,500 μg/l) under broken-ice conditions. The concentration of total hydrocarbons in the water column during the winter may exceed the acute criterion (15 μg/l for >30 days.

Construction activities would increase the turbidity in the water column along segments of a 100-mi corridor for about 1.7 to 3.4 months, but there would be no overall degradation of the water quality.

<u>Summary</u>: The discharge of drilling muds and cuttings and other discharges associated with exploration drilling are not expected to have any effect on the overall quality of the Cook Inlet water. Within a distance of between 100 and 200 m from the discharge point, the turbidity caused by SPM in the discharged muds and cuttings is expected to be diluted to levels that are less than the chronic criteria (100-1,000 mg/l) and within the range associated with the variability of naturally occurring SPM concentrations. Mixing in the water column would reduce the toxicity of the drilling muds that, in general, are practically nontoxic, to levels that would not be harmful to organisms in the water column. In general, the amounts of additives in the other discharges are expected to be relatively small (from 1 to 100 or 200 g/month) and diluted with seawater several hundred to several thousand time before being discharged into the receiving waters.

The discharge of produced waters is not expected to degrade the quality of Cook Inlet water. Mixing and weathering processes continuously will reduce the concentrations of the hydrocarbons in the produced waters. Mixing is expected to reduce the concentrations of the nonvolatile hydrocarbons and TAH's to concentrations that are less than the chronic criteria of 15 μg/l and 10 μg/l, respectively. The pH of the produced waters is expected to be within the range specified by the USEPA. The salinities of the produced waters would be within the range of salinities that are found in Cook Inlet. The discharge of metals, as indicated by zinc, generally would be less than the amounts that streams and rivers discharge into Cook Inlet. Mixing in the water column would reduce the toxicities of the produced waters that, in general, may range from slightly toxic to practically nontoxic prior to discharge.

Small oil spills, as represented in this analysis by 5- and 160-bbl spills, are not expected to have any degradational effects on the overall water quality of Cook Inlet. The small spills would degrade the water quality for a relatively short period of time, perhaps up to about 10 days, in areas of less than about 50 km^2. As noted in Section III.A.5.c(4)(e), the concentration of any of the various types of hydrocarbons in the water column generally are quite low or below detection limits.

A large oil spill (≥1,000 bbl), as represented in this analysis by a spill of 50,000 bbl of crude oil, would degrade the quality of Cook Inlet water for a period of about a month or longer in an area that might extend over several thousand square kilometers; the probability of such a spill occurring is estimated to be 21 percent. If the spill occurs within a relatively short period of time, as measured in hours, the hydrocarbon concentration in the water column generally is expected to be less than the acute criterion (1,500 μg/l) within several days. However, the hydrocarbon concentration may remain greater than the chronic criterion (15 μg/l) for a month, or more.

Conclusion: The permitted, routine discharges associated with oil and gas development and small (< 1,000-bbl) oil spills are not expected to cause any measurable overall degradation of Cook Inlet water quality; routine discharges would be prohibited in the deferred areas (about 10% of the Sale 149 area) and the amounts discharged reduced (about 4-25%). Water quality would be reduced from good (unpolluted) to polluted by the presence of hydrocarbons from one or more large (≥ 1,000-bbl) oil spills that have a relatively low chance (21%) of occurring. Contamination (the presence of hydrocarbons in amounts > 15 μg/l) would be temporary (last for a month, or more) and affect an area of several thousand square kilometers.

b. Effects on Lower Trophic-Level Organisms: Routine activities associated with the Pollock-Spawning Area Deferral Alternative (Alternative VI) that may affect lower trophic-level organisms include seismic surveys, drilling discharges, and dredging or construction. Accidental activities include exposure to petroleum-based hydrocarbons from an oil spill. The effects of these routine and accidental activities on lower trophic-level organisms are discussed in the base case (Sec. IVI.B.1.b) and are summarized below. The following analysis for Alternative VI focuses on the differences in the amount of activity (the only variable) estimated for Alternative VI as compared to that of the base case. It then estimates the resulting effect of this difference on lower trophic-level organisms for Alternative VI.

Alternative VI would delete 42 partial and whole blocks, or about 10 percent of the sale area discussed in the base case. This would eliminate any OCS activity in the deferral areas and would eliminate them as areas where a platform oil spill could originate. However, platforms outside the deferral areas still would be a potential oil-spill source that could affect the deferral areas. More importantly, the probability of one or more oil spills ≥ 1,000 bbl occurring from an oil tanker or pipeline (the primary oil-spill sources) for the deferral areas would be nearly the same (2% difference) as the base case (Appendix B, Table B-1). Hence, in terms of an oil spill, the essential difference between Alternative VI and the base case is the extra time it would take for a platform (now outside of the deferral area for Alternative VI) spill to reach deferral-area shorelines. This extra time would reduce the amount of toxic hydrocarbons reaching deferral-area shorelines. However, the surface oil (the most damaging aspect of spilled oil) still would reach these shorelines. Further, because of the speed of water movement in Cook Inlet/Shelikof Strait, the reduction in toxicity that would occur while the oil was traversing the deferral areas (although large for Alternative VI) may be relatively small, depending on where the spill originated. For these reasons, and because there only would be a minor change from the base case in the probability of an oil spill from the primary oil-spill contributors (tankers and pipelines), the effects of Alternative VI on lower trophic-level organisms are expected to be essentially the same as discussed for the base case and are summarized below.

Seismic surveys are expected to have little to no effect on lower trophic-level organisms. Drilling discharges are estimated to affect < 1 percent of the benthic organisms in the sale area and none of its plankton. Recovery is expected to occur within 1 year. Dredging and construction are expected to have little or no effect on plankton communities. Less than 1 percent of the immobile benthic organisms would be affected. Immobile benthic communities affected by pipeline construction are expected to recover in < 3 years. The effects of petroleum-based hydrocarbons on phytoplankton, zooplankton, and benthic organisms range from sublethal to lethal. Where flushing times are longer and water circulation is reduced (e.g., bays, estuaries, and mudflats), adverse effects are expected to be greater, and the recovery of the affected communities is expected to take longer. Large-scale effects on plankton due to petroleum-based hydrocarbons have not been reported. Assuming that a large number of phytoplankton were contacted by an oil spill, the rapid replacement of cells from adjacent waters and their rapid regeneration time (9-12 hours) would preclude any major effect on phytoplankton communities. Observations in oiled environments have shown that zooplankton communities experienced short-lived effects due to oil. Affected communities appear to rapidly recover from such effects because of their wide distribution, large numbers, rapid rate of regeneration, and high fecundity. Large-scale effects on marine plants and invertebrates due to petroleum-based hydrocarbons have not been reported. The sublethal effects of oil on marine plants include reduced growth and photosynthetic and reproductive activity. The sublethal effects of oil on marine invertebrates include adverse effects on reproduction, recruitment, physiology, growth, development, and behavior (feeding, mating, and habitat selection).

Based on the assumptions discussed in the text (see Sec. IVI.B.1.b), the assumed oil spill for Alternative VI is estimated to have sublethal and lethal effects on 1 to 5 percent of the phytoplankton and zooplankton populations in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. The total percentage of plankton affected could increase to 5 percent if many embayments were contacted by the spill. Recovery within the affected embayments is expected to take 1 to 2 weeks. Marine plants and invertebrates in subtidal areas are not likely to be contacted by an oil spill, but marine plants and invertebrates in intertidal and shallow subtidal areas are likely to be contacted by an oil spill. Based on the assumptions discussed in the text (see Sec. IV.B.1.b), the assumed oil spill for Alternative VI is estimated to have lethal and sublethal effects on about 20 to 30 percent of the intertidal and shallow subtidal marine plants and invertebrates in the sale area. Recovery of these communities is expected to take 2 to 3 years in high-energy habitats and up to 7 years in lower energy habitats. Small oil spills (estimated total of 495 bbl) may adversely affect individual lower trophic-level organisms in small areas immediately around the spills. However, they are not expected to have perceptible effects on lower trophic-level organisms at the population level.

Conclusion: Alternative VI is expected essentially to have the same effect as that of the base case. The assumed oil spill associated with Alternative VI is estimated to have lethal and sublethal effects on 1 to 5 percent of the plankton in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 2 weeks for zooplankton. It also is estimated to have lethal and sublethal effects on about 20 to 30 percent of the intertidal and shallow subtidal marine invertebrates in the sale area. Recovery of these communities is expected to take 2 to 3 years in high-energy habitats and up to 7 years in lower energy habitats. Less than 5 percent of the subtidal benthic populations in the sale area are expected to be affected. All of the above effects are based on the assumptions discussed in the text (e.g., the 50,000-bbl-oil spill occurs, and land segments having a probability of occurrence and contact ≥1% are contacted).

c. **Effects on Fisheries Resources:** This deferral alternative removes lease blocks from the sale area that are important to pollock in the lower portion of the sale area adjacent to Cape Douglas. This reduces the probability of a spill from pipelines or platforms and reduces the amount of noise and disturbance in and around a main pollock-spawning area. The effect of this deferral alternative will be examined using 30-day conditional probabilities for the summer season on the fisheries-resource areas in the sale area that could be affected under the base case. Effects on fisheries due to (1) oil spills and oil pollution, (2) noise and disturbance, and (3) habitat loss and/or alteration have been analyzed and appear in full under the base case (Sec. IV.B.1.c).

The effects of an oil spill were reviewed for fisheries resources in the sale area. Sale-specific oil-spill effects on fisheries resources have been estimated using combined probabilities generated from the OSRA model. Effects on fisheries derived from the EVOS studies were used to estimate potentially lethal effects of an oil spill on fisheries resources. Sale-specific oil-spill effects are not expected to directly affect returning adult salmon or steelhead. Oiled intertidal areas could cause an increased mortality to pink salmon eggs in the affected areas, but the increased egg mortality is not expected to cause reduced adult survival. An increased level of developmental malformations and increased egg-larval mortality, could cause reduced survival to adulthood in herring populations affected by an oil spill. These effects are expected to be limited to the year-class spawned during the spill year and be masked to some extent by the contribution of other year-classes to the herring population. Eggs and larvae of some semidemersal and demersal fishes may suffer increased mortality from oil contact. Also, some demersal fish populations could be exposed to oil in the event of a spill, and a few individuals could be killed. Based on experience of the EVOS, however, it is unlikely there would be any population-level effects to demersal fishes.

Indirect effects such as ingesting oil from contaminated food could cause slower growth of pink salmon juveniles due to the metabolic cost of depurating the hydrocarbon burden. This may have caused an incremental reduction in survival to adulthood, but it is not expected to have population level effects.

Fisheries resources could be disturbed and displaced from the immediate vicinity of drilling discharges within a radius probably not to exceed 100 m. These effects on demersal fishes very likely would be limited to only the short time periods of the discharge. Offshore construction also could temporarily disturb and/or displace fisheries resources. Any disturbance or displacement should be short term (hours to days), limited to only the time of construction and shortly thereafter. Though seismic surveys may damage eggs and larvae of some fishes, this injury is limited to within a meter or two from the airgun-discharge ports. Thus, seismic surveys probably would have no appreciable adverse effects on fish populations.

The Pollock-Spawning Area Deferral Alternative buffer zones are very effective in reducing risk to certain fisheries resources in lower Cook Inlet, particularly larval pollock and pollock eggs in the southern portion of lower Cook Inlet near Cape Douglas. Based on the summer 30-day conditional risk contours, the chance of spills contacting from production are moderately reduced along western Shelikof Strait from Cape Douglas (ERA 7) to Hallo/Kukak Bays (ERA 9). Half the area is eliminated for Cape Douglas, where the chance of contact is from 50 to 75 percent and for Hallo/Kukak Bays, where the chance of contact is from 25 to 50 percent (Appendix B, Figs. B-7, B-9). There also is reduced chance of contact near the Barren Islands (ERA 6), where about one quarter of the area is eliminated, where the chance of contact is from 5 to 25 percent. Other environmental resource areas in the planning area with very minor reductions in chance of contact because of the deferral are outer Kamishak Bay (ERA 4), Shuyak Island (ERA 8) and Katmai Bay (ERA 11).

This alternative reduces the risk of an oil spill from platforms or pipelines to pollock larvae and eggs in Shelikof Strait from Cape Douglas to Hallo/Kukak Bays. There also is some reduction in risk to other demersal fishes in the area including halibut, cod, and sablefish. Fisheries resources around the Barren Islands, Shuyak Island, and Cape Douglas also are afforded some additional protection by this alternative.

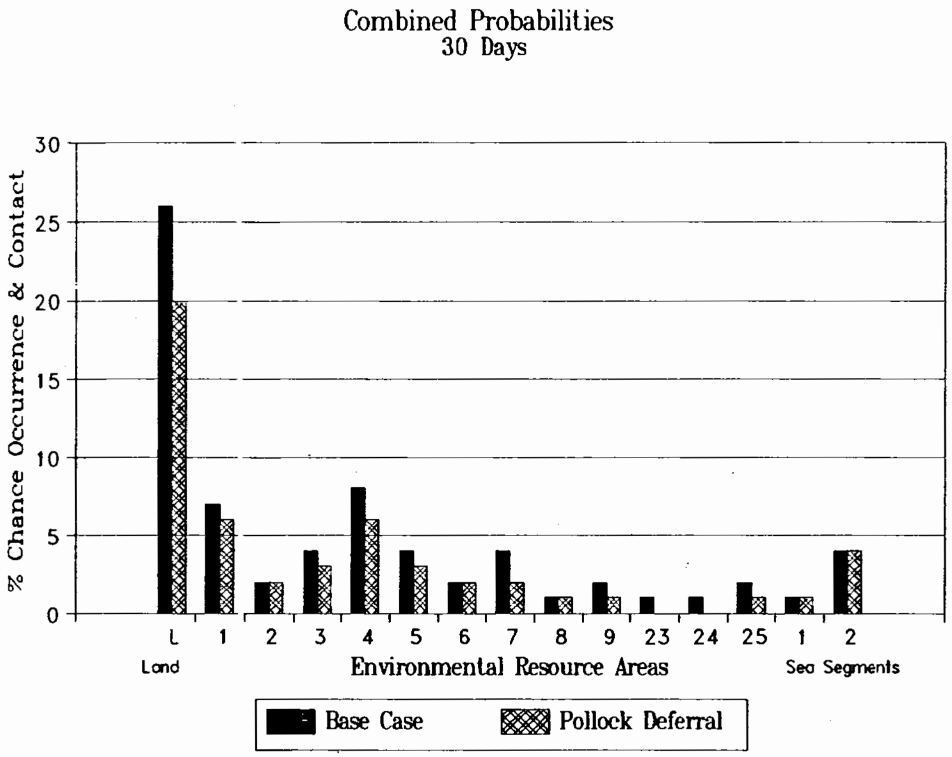
In summary, the estimated spill effects under the pollock-spawning area deferral are reduced, reducing the potential for mortality to pollock eggs and larvae and the eggs and larvae of other semidemersal and demersal fish. The estimated spill effects to salmonids and herring essentially are unchanged from the base case, with potential for increased mortality to pink salmon eggs in oiled intertidal areas and an increased level of developmental malformations and increased egg-larval mortality in herring. The short-term, local effects of noise, disturbance, and habitat alteration will be lessened for species in the deferral area. These include pelagic salmonids, herring, and demersal fishes.

Conclusion: Compared to the base case, this alternative reduces the potential for an oil spill from platforms or pipelines. The overall effects of this alternative are expected to be minimal, with some possible mortality to pollock larvae and eggs in Shelikof Strait from Cape Douglas to Hallo/Kukak Bays. There also is some potential loss of eggs and larvae of other demersal fishes in the area including halibut, cod, and sablefish. Fisheries resources around the Barren Islands, Shuyak Island, and Cape Douglas also are afforded some additional protection by this alternative. As with the base case, the various effects to fisheries resources taken altogether are not expected to cause population-level changes.

d. Effects on Marine and Coastal Birds: Alternative VI would remove approximately 42 whole and partial blocks (9.60% of the sale area) from the proposed lease sale, leasing those blocks located north of Cape Douglas and northwest of the Barren Islands in lower Cook Inlet. Alternative VI would provide a potential reduction in oil-spill effects on marine and coastal birds in the northern portion of Shelikof Strait, which contain some important habitats on Afognak and Shuyak Islands. The chance of one or more oil spills ≥1,000 bbl occurring decreases from 27 percent under the base case to 21 percent under Alternative VI.

A comparison of Alternative I and Alternative VI combined probabilities (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting environmental resource areas—important habitats of marine and coastal birds—is shown in Figure V.B.6.d-1. Alternative VI reduces the probability of one or more ≥1,000-bbl spills occurring and contacting 10 of the 15 environmental resource areas estimated under Alternative I. The highest reduction in the chance of one or more ≥1,000-bbl spills occurring and contacting is to the Cape Douglas area (ERA 7, reduced from 4 to 2%); outer Kamishak Bay (ERA 4, reduced from 8 to 6%); and land in general (Land, reduced from 26 to 20%). The reductions in the combined probabilities of one or more oil spills occurring and contacting Kamishak Bay and the other environmental resource areas except Cape Douglas (ERA 7) generally reflect the reduction in the volume of oil assumed to be discovered under Alternative VI compared to the base case after the oil in the deferred tract is subtracted.

The deferral of leasing tracts near Cape Douglas and near the western coast of Afognak and Shuyak Islands could provide some protection from oil spills for these habitats by eliminating potential platform-spill locations in the deferred areas. Based on the conditional-risk contours, potential platform-spill sites in Shelikof Strait with a >25-percent conditional probability (expressed as percent chance) of contacting the Cape Douglas bird habitats (ERA 12) within 30 days during the summer would be removed (Appendix B, Fig. B-12), and most potential platform-spill sites with >50-percent chance of contacting Afognak-Shuyak Islands bird-habitat area (ERA 11) also would be eliminated (Appendix B, Fig. B-11). However, other potential platform, pipeline, and tanker spills that are potentially associated with this alternative and with the proposal are estimated to have some chance of contact to these and other important habitats and affect the bird populations. Some limited reduction of oil-spill risk to seabirds, sea ducks, and shorebirds and their habitats in the Shelikof Strait area is be expected with this alternative.



Source: Appendix B Table B-15

Figure IV.B.6.d-1. Combined Probabilities (expressed as percent chance) of One or More Spills ≥1,000 Barrels Occurring and Contacting Certain Envirponmental Resource Areas Within 30 Days Under the Base Case and Under Alternative VI Over the Assumed Production Life of Sale 149 Area.

The deferral of the southernmost portion of the sale area under this alternative would eliminate potential platform-spill sites with a >25-percent-conditional probability (expressed as percent chance) of contacting inner Shuyak Island. However, chance of contact to the Barren Islands and Tuxedni, Kachemak, and Kamishak Bays along the pipeline and tanker routes in lower Cook Inlet would remain unchanged from the risks described under the base case. Thus, the overall oil-spill effects on the Barren Island seabird-colony complex and on other marine and coastal birds in Cook Inlet are expected to remain about the same as under the base case (Alternative I).

Noise and disturbance and habitat alteration effects on marine and coastal birds are expected to be the same as described under the base-case scenario of the proposal, because both alternatives are expected to use the same transportation scenario.

Conclusion: Oil-spill effects of the proposed action on bird populations could be reduced locally in the Cape Douglas area, nearshore habitats on the western side of Afognak and Shuyak Islands, and in Kamishak Bay to a limited extent due to less oil being transported in the lease area. However, the overall effect of oil spills, noise and disturbance, and habitat alteration on marine and coastal birds (loss of several thousand to—perhaps 100,000—birds) is expected to be about the same as described under the base case.

e. **Effects on Nonendangered Marine Mammals (Pinnipeds, Cetaceans, and the Sea Otter)** This deferral alternative removes lease blocks from the sale area that are important to pollock in the lower portion of the sale area adjacent to Cape Douglas. This reduces the probability of a spill from pipelines or platforms contacting and reduces the amount of noise and disturbance in and around a main pollock-spawning area. The effect of this deferral alternative will be examined using 30-day conditional probabilities for the summer season on the most sensitive marine mammal resource areas in the sale area that could be affected under the base case. Effects on marine mammals due to (1) oil spills and oil pollution, (2) noise and disturbance, and (3) habitat loss and/or alteration have been analyzed and appear in full under the base case (Sec. IV.B.1.e).

Sale-specific oil-spill effects on marine mammal resources were estimated using combined probabilities, conditional risk contours, and conditional probabilities for transportation segments generated from the OSRA model. Mortality rates derived from the EVOS and adjusted by the SF were used to estimate potentially lethal effects of a spill on each species. Sale-specific oil-spill effects were estimated to result in the mortality of <10 fur seals and killer whales, respectively; approximately 43 beluga whales; approximately 60 harbor seals; and between 75 to 100 sea otters. Recovery to prespill numbers was estimated to occur in about 1 to 2 years, with the exception of beluga whales, where recovery may require up to 7 years.

Effects to marine mammals due to noise and disturbance also were reviewed and estimated. The loudest noise source created by industry activity was identified as seismic noise. Sounds generated by seismic surveys probably would not affect harbor and fur seal and sea otter activities. Effects on the minke whale have not been studied but likely would be similar to effects on other baleen whales, which generally are tolerant of seismic pulses. Subtle behavioral changes may occur on occasion at low-sound levels, with stronger avoidance reactions when sound levels reach 160 to 170 dB, or higher. Toothed-whale hearing appears poor at frequencies lower than 1 kHz, where most industrial sounds and seismic pulses are produced, so they probably would be unaffected.

Aircraft overflights can be another potential source of disturbance. Pinniped response to low-altitude aircraft can result in stampede or flight into the water. This may increase pup mortality during the pupping season. Both baleen and toothed whales usually respond to low overflights by diving. Reactions of pinnipeds and cetaceans vary by aircraft type, altitude of flight, and circumstances of the animals. These disturbance reactions usually are short term, with seals reoccupying haulouts and whales continuing their activities usually within a matter of hours.

The effects of habitat alteration/degradation also were examined. These would be limited to temporary disturbance to some sea otters and harbor seals in the nearshore environment associated with construction of pipeline and transport facilities. This disturbance likely would be relatively short term and very localized and should not affect survival.

The Pollock-Spawning Area Deferral Alternative buffer zones are minimally effective in reducing risk to marine mammal resources in lower Cook Inlet. Based on the 30-day summer conditional risk contours, the chance of spills contacting due to production are moderately reduced along western Shelikof Strait from Cape Douglas (ERA 7) to Hallo/Kukak Bays (ERA 9). Half the area is eliminated for Cape Douglas where the chance of contact is from 50 to 75 percent and for Hallo/Kukak Bays where the chance of contact is from 25 to 50 percent. There also is reduced risk near the Barren Islands (ERA 6), where about one quarter of the area is eliminated where the chance of contact is from 5 to 25 percent. Other environmental resources in the planning area with very minor reductions in chance of contact because of the deferral are outer Kamishak Bay (ERA 4), Shuyak Island (ERA 8), and Katmai Bay (ERA 11).

This alternative primarily reduces risk to sea otters from Cape Douglas to Hallo/Kukak Bays, with some reduction in risk to sea otters, harbor seals, fur seals, and nonendangered cetaceans around the Barren Islands, Shuyak Island, and Cape Douglas.

In summary, the estimated spill effects under the pollock-spawning deferral would be unchanged from the base case, with a potential mortality of <10 fur seals and killer whales, respectively; approximately 43 beluga whales; approximately 60 harbor seals; and between 75 to 100 sea otters. Recovery to prespill numbers was estimated to occur in about 1 to 2 years, with the exception of beluga whales, where recovery may require up to 7 years. The short-term, local effects of noise, disturbance, and habitat alteration would be lessened for the nearshore species in the deferral area. These include sea otters, harbor seals, foraging fur seals, and some nonendangered cetaceans.

Conclusion: Compared to the base case, the estimated spill effects under this deferral alternative would be unchanged, with a potential mortality of <10 fur seals and killer whales, respectively; approximately 43 beluga whales; approximately 60 harbor seals; and between 75 to 100 sea otters. Recovery to prespill numbers was estimated to occur in about 1 to 2 years, with the exception of beluga whales, where recovery may require up to 7 years. Potential noise and disturbance effects to these marine mammals due to exploration and production in these areas also would be eliminated by the deferral alternative.

f. Effects on Endangered and Threatened Species: Alternative VI (Pollock-Spawning Area Deferral) would delete all blocks in the vicinity of Cape Douglas at the southern end of the proposed sale area. The deferred area lies within a gray whale migration corridor and zone of probable seasonal occurrence of endangered whale species, areas potentially used by foraging or rafting Steller sea lions from the major Barren Islands rookery and peripheral haulouts, and adjacent to probable Steller's eider wintering habitat (Graphic 3). This alternative removes approximately 50 percent of the limited southern and southeastern sale area within which, under Alternative I (proposal, Sec. IV.B.1.f), a small proportion of these species' populations potentially could be exposed to routine exploration and development/production activities.

For these populations, the most likely sources of adverse effects associated with routine activities are disturbance (including drilling operations, aircraft and vessel traffic, and seismic surveys), and release of drilling muds and cuttings. The zone created by removing lease blocks from the sale area would be expected to reduce effects of these activities somewhat in this area as a result of the greater distance between potential platform sites and wildlife concentrations. However, as discussed for Alternative I, potential effects from routine activities already are likely to be minimal because of the likelihood that travel routes of few whales or sea lions will intersect those of vessels or aircraft, or approach a platform, and that any interaction effects (e.g., travel direction change, area avoidance) will last for less than an hour. Likewise, exposure of whales or sea lions, or their prey species, to any materials released into the environment is expected to have minimal effects due to rapid dispersal of such materials to nontoxic concentrations in this oceanographically dynamic area.

Removal of these blocks from the sale area would reduce the overall chance of one or more oil spills occurring from 27 percent under Alternative I to 21 percent (Appendix B, Table B-1), due to the reduction in projected oil resource, and also would be expected to reduce potential effects somewhat in the Cape Douglas area and northern Shelikof Strait as a result of the additional weathering and cleanup that could occur as spilled oil moves through the greater distance between potential platform spill sites and wildlife concentrations. Based on the 30-day summer conditional risk contours, deferral of blocks east of Cape Douglas (ERA 7) would eliminate potential platform oil-spill sites from which there is at least a 75-percent conditional probability (expressed as percent chance) of contact (Appendix B, Fig. B-7). The chance of oil contact ranges from 65 percent from pipeline segment P5 to 4 percent from more distant tanker segment T6; from most potential tanker or pipeline segments, the chance is <30 percent (Table B-4). While removal of the platform contribution to spill risk from these blocks reduces the chance of spill contact at a sea lion use area south of Cape Douglas (ERA 7) somewhat (1%), the relation of pipeline and tanker routes to the area, and thus risk remains essentially unchanged from Alternative I. The combined probability (expressed as percent chance) of one or more oil spills from these sources, or from a platform outside the buffer, occurring and contacting sea lion haulout areas along Shelikof Strait is reduced from a maximum of 4 percent to 2 percent near Cape Douglas (ERA 7). South of this resource area (ERA 9), the chance of occurrence and contact is reduced just 1 percent and remains unchanged at ≤0.5 percent along the remainder of Shelikof Strait (Table B-14, B-15; Fig. IV. A.2-6), so the risk to sea lions in this area is expected to remain essentially as discussed under Alternative I: the potential loss of a few tens of individuals requiring at least one generation for recovery. This alternative also would reduce potential effects on Steller's eiders wintering south of Cape Douglas from those discussed under Alternative I (oil-spill losses requiring 2 generations for recovery).

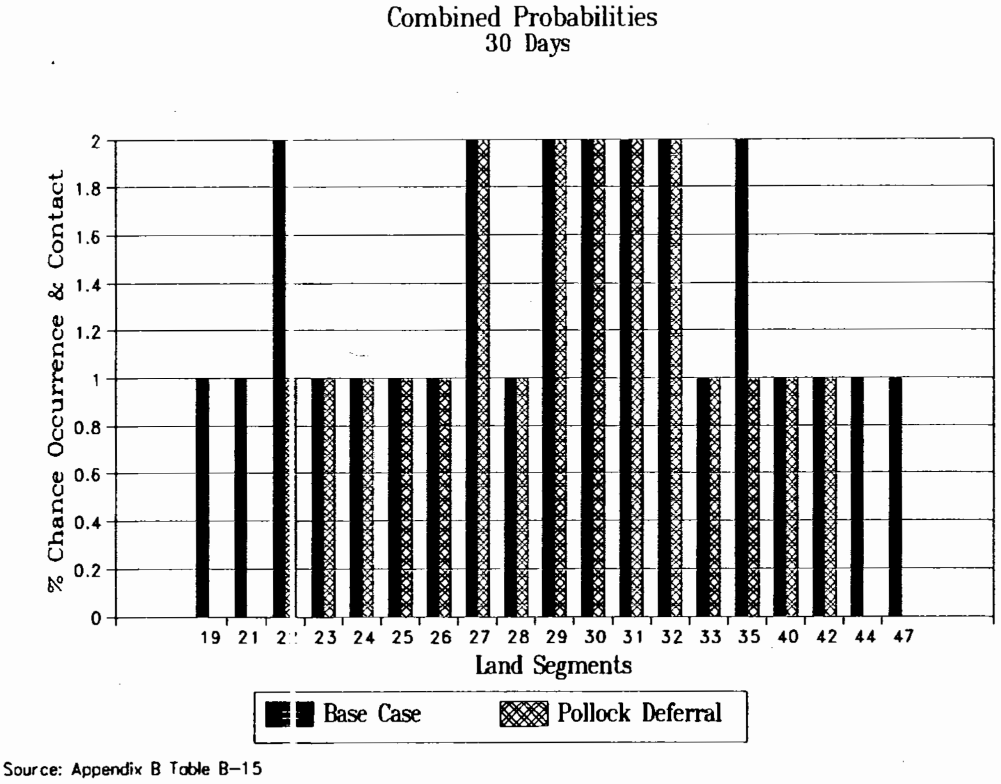
Deferral of blocks from the southern sale area may provide some limited relief from disturbance and possible contact with drilling muds and cuttings, minor contaminants, and any oil spilled for the small numbers of endangered whales, and Steller sea lions, that transit or occupy the southeastern portion of the proposed sale area by removing potential platform sites and associated support activities farther from Cape Douglas, the Barren Islands, and migration routes and foraging areas in northern Shelikof Strait. Thus, potential impacts under this alternative are expected to be reduced to a limited extent from those discussed under Alternative I, which include: (1) Exposure of ≤1 percent of the North Pacific fin whale and 5 percent of humpback whale populations occurring in this area to disturbance, with individuals being affected for an hour or less per incident. (2) Similarly, small numbers of whales exposed to an oil spill, with any effects sublethal and short-term. (3) A tanker spill outside entrances to Cook Inlet/Shelikof Strait contacting larger numbers of whales east of Kodiak Island, but without the occurrence of any mortality. (4) Less than 2 percent of the central Gulf of Alaska Steller sea lion population (5% of the potentially affected area population) exposed to potentially disturbing activities, with no rookeries or haulouts likely to be disturbed. (5) An oil spill potentially contacting up to several hundred sea lions, but adult mortality not exceeding a few tens of individuals—survivorship of pups and juveniles more severely affected. (6) Overall sea lion mortality resulting from an oil spill is expected to be < 100 individuals, requiring a recovery period of at least one generation. (7) No endangered or threatened bird populations are expected to be affected by exploration or development/production activities. (8) Effect on Steller's eider requiring three generations for recovery.

In summary, the Pollock-Spawning Area Deferral Alternative could result in decreased potential for oil-spill contact of sea lions and endangered whales in southern Cook Inlet and northern Shelikof Strait as a result of the reduced oil resource projected and elimination of platforms from the deferred area; however, such reduction is expected to be limited and local because of the already low chance of one or more spills occurring and contacting and the limited seasonal occurrence of these species there. Potentially disturbing activities and minor contaminants are expected to be reduced somewhat from the minimal Alternative I levels in this area.

Conclusion: The overall effect of this alternative on endangered whales is expected to be somewhat less than the minimal effect discussed under Alternative I; likewise, effect on the Steller sea lion is expected to be somewhat reduced from the Alternative I determination that loss of a few tens of individuals from oil-spill effects could require a recovery period of at least one generation. Oil-spill effect on the Steller's eider is expected to be slightly reduced from the two generations required for recovery.

g. Effects on Terrestrial Mammals: This alternative would remove approximately 42 whole and partial blocks (9.60% of the sale area) from the proposed lease sale, leasing those blocks located north of Cape Douglas and northwest of the Barren Islands in lower Cook Inlet. Alternative VI, the Pollock-Spawning Area Deferral Alternative, is expected to provide for a potential reduction in oil-spill effects on terrestrial mammal coastal habitats in the northernmost part of Shelikof Strait. The chance of one or more oil spills ≥1,000 bbl occurring decreases from 27 percent under Alternative I to 21 percent under Alternative VI.

A comparison of Alternative I and Alternative VI combined probabilities (expressed as percent chance) of one or more ≥1,000-bbl-oil spills occurring and contacting land segments representing coastal habitats of terrestrial mammals is shown in Figure IV.B 6.g-1. Alternative VI reduced the probabilities of one or more ≥1,000-bbl spills occurring and contacting 6 of the 19 land segments estimated under Alternative I. The combined probabilities of one or more ≥1,000-bbl spills occurring and contacting are reduced for the following areas: Hallo Bay (LS 19) north to Cape Douglas (LS's 21-22), Kalgin Island (LS 35), Kachemak Bay on the Kenai Peninsula (LS 44), and the western Barren Islands (LS 47). The reductions in the chance of one or more ≥1,000-bbl spills occurring and contacting Hallo Bay (LS 19) and the Cape Douglas area (LS's 21, 22, and 23) reflect the protection of the buffer zone deferred tracts under this alternative. Reductions in the combined probability to the other coastal



Source: Appendix B Table B-15

Figure IV.B.6.g-1. Combined Probabilities (expressed as percent chance) of One or More Spills ≥ 1,000 Barrels Occurring and Contacting Certain Land Segments within 30 Days Under the Base case and Under Alternative VI Over the Assumed Production Life of Sale 149 Area.

habitats generally reflect the reduction in oil volume expected to be produced under this alternative compared to production under the base case.

The deferral of leasing tracts offshore of Cape Douglas (LS 22) could provide some protection from oil spills for these habitats by eliminating potential platform-spill locations in the area. This alternative would eliminate most potential platform-spill sites that have a >25-percent estimated conditional probability (expressed as percent chance) of contacting Cape Douglas (LS 22; Johnson et al., 1994) within 30 days during the summer and eliminate potential platform spill-sites that have a ≥5-percent estimated conditional probability (expressed as percent chance) of contacting the northwest coast of Afognak and Shuyak Islands (LS's 74-75, Johnson et al., 1994).

Thus, there would be some local reductions of oil-spill effects on brown bears, river otters, and other terrestrial mammals and their habitats along the coastline of Cape Douglas and Hallo Bay area. Reductions in combined probabilities for other coastal habitats in Cook Inlet are related more to the reduced volume of oil estimated to be produced and a subsequent reduction in the chance of spill occurrence rather than deferral of leasing tracts near the coast. A reduction in potential platform-spill risks to Afognak and Shuyak Islands also is estimated under this alternative. However, oil-spill risks from a potential oil spill along the pipeline route to the Kenai Peninsula or along the assumed tanker route in and out of Cook Inlet would remain unchanged. Thus, the potential overall oil effects on terrestrial mammals are expected to remain about the same as described under the proposal.

Noise and disturbance and habitat-alteration effects on terrestrial mammals are expected to be the same as described under the base case of the proposal, because both alternatives are assumed to use the same transportation scenario with the same amount and location of air and vessel traffic and the same onshore support facilities to be constructed.

<u>Conclusion</u>: Oil-spill effects on brown bears, river otters, and other terrestrial mammals are expected to be reduced locally along the coastline of Hallo Bay and Cape Douglas and, to a lesser extent, along the coast of Afognak and Shuyak Islands. However, the overall effect of oil spills, noise and disturbance, and habitat alteration on terrestrial mammals (loss of perhaps <50 river otters, 100 deer, and 10 bears) is expected to be about the same as under the base case.

h. <u>Economy</u>: Increased employment is the most significant economic effect generated by Alternative VI, the Pollock-Spawning Area Deferral. Employees would work on the construction, operation, and servicing of facilities associated with the sale—3 exploration wells, 4 delineation wells, 3 production platforms, 40 production/service oil wells, 1 shore base, and 95 mi of offshore pipeline.

Direct OCS resident employment on the western side of the Kenai Peninsula would start with 332 in 1997; drop to 245 in 1998; rise to 694 in 1999, 1,054 in 2000, and 1,363 in 2001; drop to 1,173 in the year 2002 and 834 in 2003; and vary between 834 and 853 through the year 2020. Indirect resident employment is estimated to be 12.6 percent of direct OCS-resident employment and would peak at 172 for the year 2001. (See Appendix G for a description of the methodology for employment and population forecasts. Also see Sec. IV.B.1.h, Economy, for assumptions and general analytic methods for this alternative.)

Resident employment on the western side of the Kenai Peninsula is estimated to be 15,986 for 1995 and is projected to rise 0.9 percent annually without the sale. Between the years 1997 and 2003, direct OCS employment and indirect employment would increase and decrease, resulting in changes of between zero and 3 percent of total employment each year.

The OCS activity could generate effects on other facets of the economy including income, prices, and taxes. The OCS workers likely would earn relatively high wages compared to the average income on the western part of the Kenai Peninsula. Even assuming the income of the OCS workers were twice as high as the average for the western Kenai Peninsula, the effect on the average income would be a <3-percent change for <5 years. This is because the largest rise for 1 year in direct OCS employment is 449 workers in 1999 compared to resident employment of 16,422 in 1998.

The <3-percent rise in average income for <5 years is the basic economic driving force of price inflation. The maximum rise in resident employment of <3 percent for 1 year, even assuming that the average income is twice the average for the Kenai Peninsula Borough (KPB) for 694 direct OCS workers, translates to price inflation of <3 percent for <5 years for the western Kenai Peninsula. Because of the relatively short time—6 years for the exploration and development phase—that housing would be needed for the large number of OCS workers, it is assumed that temporary housing would be provided by OCS lessees for approximately half of the OCS workers in these three peak years. In the peak year 2001, temporary housing would be provided for about 700 OCS workers.

Revenue from property tax would increase <2 percent for <5 years for the KPB. The value of taxable improvements to property during a peak year is estimated to be $50 million (1993 dollars), which is 1.6 percent of the total taxable valuation for the KPB in 1993 (Barnes, 1993, personal comm.). The primary components of taxable improvements are improvements in existing facilities equivalent to a new shore base and new housing for workers. These would be constructed primarily in the years 1997 to 2001. It is assumed that 200 permanent housing units would be built for each year for the 4 years following exploration, 1999 to 2002. At an average value of $100,000 per housing unit, the average value of new housing per year would be $20 million. The value of improvements to shore-base facilities is estimated to be $30 million for the peak year. The values are given in 1993 dollars.

Annual property-tax revenue of $2.2 million would accrue to the KPB and $0.4 million (1993 dollars) to the State after all major improvements are constructed or installed, which would be 2002. The improvements are estimated to be $100 million for shore-base improvements and $80 million for 800 new housing units. The $180 million of improvements at the rate of 12 mills results in property-tax revenue of $2.2 million. The mill rate of 12 is the approximate average of the mill rates for seven tax-code areas between Anchor Point and Nikiski; the mill rate accruing to the State of Alaska for oil facilities in this case is 8 (Alt, 1993, personal comm.). It is assumed that half of the shore-base improvements are oil facilities.

If the KPB had a sales tax during the period of OCS activity, the expenditures by direct OCS workers and indirect workers would translate to a maximum sales-tax revenue change of <5 percent for <5 years. This is because the sales-tax revenue would be in proportion to the increase in total income for all additional OCS workers in 1 year; and it is assumed that the income for OCS workers would be twice that of the average worker for the western Kenai Peninsula.

Headquarters employment is assumed to be located in Anchorage. It would rise from 10 in 1995 to 100 in 2003, to 200 from 2004 through 2012, and drop to 180 from 2013 through 2021. It would result in changes that are <1 percent of Anchorage employment in any given year.

The economic effects of oil spills <1,000 bbl would be very minimal. These small spills would be cleaned up by CISPRI or some similar organization. A spill <1,000 bbl would require <50 person hours to clean up.

The most relevant historical experience in Alaskan waters of a tanker spill of 109,000 bbl (average tanker-size spill, see Sec. IV.A.2.a(4)) is the EVOS of 1989, which spilled 240,000 bbl. This spill generated enormous employment that rose to the level of 10,000 workers directly doing cleanup work in relatively remote locations. Smaller numbers of cleanup workers returned in the warmer months each year following 1989 until 1992. Numerous local residents quit their jobs to work on the cleanup at often significantly higher wages. This generated a sudden and significant inflation in the local economy (Cohen, 1993). Anecdotal information indicates that housing rents in Valdez in 1989 increased from 25 percent in some cases to sixfold in others, and inflated rents continued into 1990. Prices of food and other goods increased only slightly, because people could drive to Anchorage to purchase them (Henning, 1993, personal comm.). Research shows that no data on inflation were gathered in a systematic way during the EVOS, although most observers agree that there was temporary inflation.

The number of cleanup workers actually used for a spill associated with Sale 149 would depend to a great extent on what procedures are called for in the oil-spill-contingency plan, how well prepared with equipment and training the entities responsible for cleanup are, how efficiently the cleanup is executed, and how well in reality the coordination of cleanup is executed among numerous responsible entities. A spill resulting from activity associated with Sale 149 could generate half the workers associated with the EVOS, or 5,000 cleanup workers. Housing rents in the western Kenai Peninsula probably would double for 1 year following a major spill.

Conclusion: Alternative VI would generate changes that are the same as the base case. These changes would be between zero and 3 percent in resident employment, <3 percent in average income, <5 percent in cost of living, <2 percent in property tax, and <5 percent in sales taxes on the western side of the Kenai Peninsula annually for

<5 years. Property-tax revenue of $2.2 million for the KPB and $0.4 million for the State (in 1993 dollars) would be added annually after the year 2002.

A large oil spill would generate 5,000 cleanup jobs for 6 months in the first year, declining to zero by the fourth year following the spill. Local communities would experience a doubling of housing rents for 1 year.

i. **Effects on Commercial Fisheries:** Activities and events associated with the Pollock-Spawning Area Deferral Alternative (Alternative VI) that may affect the Cook Inlet commercial-fishing industry include drilling discharges, offshore construction, seismic surveys, and oil spills. The effect of these activities and events on the Cook Inlet commercial-fishing industry are discussed in the base case (Sec. IV.B.1.i) and are summarized below. The following analysis for Alternative VI focuses on the differences in the amount of activity (the only variable) estimated for Alternative VI as compared to that of the base case. It then estimates the resulting effect of this difference on the Cook Inlet commercial-fishing industry for Alternative VI.

This alternative would delete 42 partial and whole blocks, or about 10 percent of the sale area discussed in the base case. This eliminates any OCS activity in the deferral areas and would eliminate them as areas where a platform oil spill could originate. The probability of a platform spill occurring is estimated to be 9 percent compared to 12 percent for the base case. However, platforms outside the deferral areas still would be a potential oil-spill source that could affect the deferral areas. Also, the probability of one or more oil spills occurring from a tanker or pipeline for the deferral areas would be only slightly less (2% and 3%, respectively) than the base case. Hence, in terms of an oil spill, the only difference between this alternative and the base case is the extra time it would take for a platform (now outside of the deferral areas for Alternative VI) spill to reach the deferral areas. While this extra time likely would reduce the toxicity of the oil entering the deferral areas, it likely would not reduce the severity of economic losses to the commercial-fishing industry due to closures. For these reasons, the effects of Alternative VI on the commercial-fishing industry are expected to be essentially the same as discussed for the base case; they are summarized below.

Drilling discharges associated with the base case are not expected to have an effect on commercial fishing due to the limited area affected near the platform-discharge point. Offshore construction, platforms, and pipelines are expected to result in some space-use conflicts (e.g., competition for docking space or gear loss); however, these are expected to be few in number and minor in scope. Seismic surveys, planned and coordinated with the commercial-fishing industry, are expected to have a minimal effect on the Cook Inlet commercial-fishing industry. Due to the relatively small amount of oil involved (495 bbl), the 37 small oil spills (Table IV.A.2-4d) assumed for the Pollock-Spawning Deferral Alternative are not expected to result in closures or reduced market values over the life of the proposal. Hence, they are not expected to have a measurable economic effect on the Cook Inlet commercial-fishing industry. However, the assumed large (50,000-bbl) oil spill is expected to affect pot, longline, trawl, drift-gillnet, and set-gillnet fisheries in Cook Inlet.

The estimated economic effect of the large (50,000-bbl) oil spill on the Cook Inlet commercial-fishing industry is based on what occurred during the EVOS and *Glacier Bay* oil spill, and primarily depends on the highly variable EVOS cost estimates (ranging from $9-43 million/year for 2 years). From 1983 to 1993, the value of the Cook Inlet commercial fishery appears to have ranged between about $50 and $135 million/year. Based on the above, in any 2-year period when the value of the Cook Inlet commercial fishery is estimated to be about $50 million/year, a 2-year loss of about $9 million/year represents an 18-percent/year loss for 2 years, whereas a 2-year loss of about $43 million/year represents an 86-percent/year loss for 2 years. In a 2-year period when the value of the Cook Inlet commercial fishery is estimated to be closer to $135 million/ year, a 2-year loss of about $9 million/year represents a 7-percent/year loss for 2 years, whereas a 2-year loss of $43 million/year represents a 32-percent/year loss for 2 years. Because the occurrence of a large oil spill would preclude any knowledge of what the commercial fishery would have been worth, the value of the commercial fishery at the time of the assumed 50,000-bbl-oil spill is assumed to be the average annual value (1983-1993) of the Cook Inlet commercial fishery. Thus, in terms of the average annual value of the Cook Inlet commercial fishery (about $65 million), the assumed base-case oil spill is estimated to result in an economic loss of about 15 to 65 percent/year for 2 years. Estimated losses to the Kodiak commercial-fishing industry are expected to be less than half of those estimated for Cook Inlet, or about 5 to 25 percent/year for 2 years following the assumed 50,000-bbl Cook Inlet oil spill. This amounts to an estimated loss of about $4 to $19 million/year to the Kodiak commercial-fishing industry. However, the EVOS experience has demonstrated that compensation to the commercial-fishing industry for participating in the cleanup of a large Cook Inlet oil spill is likely to exceed these economic losses by several orders of magnitude.

Conclusion: Based on the assumptions discussed in the text (i.e., a 50,000-bbl spill occurs during the commercial-fishing season), EVOS-loss estimates, and the average annual value of the Cook Inlet commercial fishery, the Pollock-Spawning Area Deferral Alternative is estimated to result in economic losses to the Cook Inlet commercial-fishing industry ranging from about 15 to 65 percent/year for 2 years following the assumed 50,000-bbl-oil spill. Losses to the Kodiak commercial-fishing industry from the same spill are estimated to range from about 5 to 25 percent year for 2 years following the spill. The chance of one or more oil spills ≥ 1,000 bbl is estimated to be 21 percent.

j. Effects on Subsistence-Harvest Patterns: The effects-producing factors for Alternative VI, the Pollock-Spawning Area Deferral Alternative are the same as for the base case, including routine operations, such as seismic surveys, the disposal of drilling muds and cuttings, and the operation of support facilities, as well as accidental events such as oil spills.

Geographically, the deferral of all southern blocks of the proposed sale area near Cape Douglas to protect a pollock-spawning area could provide a measure of protection for subsistence resources, especially marine mammals, which use pollock as a major food source. Besides selective block deferral, Alternative VI also differs from the base case in a reduction in the number of exploration and delineation wells drilled from 8 in the base case to 7, a reduction in the number of production wells drilled from 48 in the base case to 40, a reduction in the amount of oil produced by 50 MMbbl, and a reduction in the length of pipeline used from 125 mi in the base case to 95 mi in this alternative. Reduced effects on subsistence resources could occur from these reductions through factors such as the discharge of reduced amounts of drilling muds and cuttings and reduced numbers of helicopter and vessel trips in comparison to the base case, although such reductions may not produce measurable effects reductions.

Other than these factors, Alternative VI is the same as the base case in terms of the estimated number of platforms used, the number and location of pipeline landfalls, the number and location of shore bases, the number of exploratory and production rigs used per year, and the number of years used for exploration and production well drilling. Effects on subsistence-harvest patterns from these factors should be the same as for the base case.

Effects on subsistence-harvest patterns from oil-spill events essentially would be the same as the base case in that the production and transportation scenarios are the same as the base case, there is a 6-percent reduction (20% vs. 26% in the base case) in the chance of one or more oil spills ≥ 1,000 bbl occurring and contacting land within 30 days, and most of the contacts with land segments occur on the west side of Cook Inlet, relatively removed from subsistence-harvest areas (Appendix B, Table B-14).

As a consequence of the above, effects on subsistence-harvest patterns in Alternative VI would be most prominent among southern Kenai Peninsula communities and the communities of Nanwalek and Port Graham. These communities could experience subsistence-resource loss, primarily because of the high level of exposure to spills from transportation sources, should they occur. Such losses could include the lack of resource availability, accessibility, or desirability for use. Reductions in subsistence-harvest levels for specific resources could extend for a year or more. Elsewhere in Cook Inlet and on Kodiak Island and the Alaska Peninsula, effects on subsistence-harvest patterns are estimated to be limited in magnitude and duration and not of such a nature as to cause measurable changes in the availability, accessibility, or desirability of most subsistence resources.

Conclusion: Effects on subsistence-harvest patterns are expected essentially to be the same as Alternative I (base case), in that subsistence harvests would be reduced or substantially altered by as much as 50 percent in one or more southern Kenai Peninsula communities for at least 1 year and, to a lesser extent, for selected subsistence resources 2 to 3 years beyond. However, deferral of all southern blocks near Cape Douglas could provide a measure of protection for subsistence resources, especially marine mammals, which use pollock as a major food source.

k. Effects on Sociocultural Systems: The effect-producing factors for Alternative VI, the Pollock-Spawning Area Deferral Alternative, include prelease and postlease planning processes, the introduction of industrial activities and changes in community population and/or employment levels, potential effects on subsistence-harvest patterns, and effects from accidental oil spills and cleanup efforts.

Effects on sociocultural systems begin with the prelease processes of announcing the proposed sale and carrying out the preparation of an EIS. Given a significant oil discovery, planning processes are again engaged to prepare a developmental EIS. Each of these sometimes lengthy processes causes stress and anxiety among affected publics, although the stakes would be different. The discussion under the base case (Sec. IV.B.1.k.) explores the types of impacts involved.

This alternative has the same technical characteristics as the base case regarding the number of platforms used, the number and location of pipeline landfalls, the number and location of shore bases, the number of exploratory and production rigs used per year, and the number of years used for exploration and production well drilling. It differs from the base case in the number of exploration and delineation wells drilled (reduced from 8 to 7), the number of production wells drilled (from 48 in the base case to 40), the amount of oil produced (reduced by 50 MMbbl), and the length of pipeline used (reduced from 125 to 95 mi).

As discussed for the base case, it is more likely that the population associated with OCS-related industrial activities would be distributed within the central Kenai Peninsula area than with the distribution of population established in the 1990 census of population. Accordingly, Table IV.B.6.k-1 shows this distribution to represent a percentage of increase in population for the mid-Peninsula area the same as that of the base case, except for slight differences in the years 1998 and 2000 to 2002. Consequently, effects on sociocultural systems from population increases generally should be the same as for the base case.

Effects on subsistence-harvest patterns from oil-spill events would be the same as for the base case in that the number of spills assumed to occur and the production and transportation scenarios are the same as for the base case. Likewise, effects from oil-spill and cleanup events would be the same as for the base case.

As a consequence of the above, effects on sociocultural systems in Alternative VI would be centered on the Kenai Peninsula, including the Alutiiq communities of Nanwalek and Port Graham. Resident population associated with the sale would do little to change existing sociocultural systems in the central Kenai Peninsula area, where new resident population would be expected to live. Despite the limited (20%) chance that one or more oil spills ≥1,000 bbl would occur and contact land the individual, social, and institutional effects from these and tanker spills, should they occur, could be serious. Individual and social stress and anxiety levels would be expected to increase in southern Kenai Peninsula communities over the loss of subsistence resources, contamination of habitat, fear of the health effects of eating contaminated wild foods, and the need to depend on the knowledge of others about environmental contamination. In the Alutiiq communities, the organization of subsistence activities among kinship and friendship groups and the relationships among those that customarily process and share subsistence harvests also could be modified or could decline in importance. Stress-induced increases in alcohol and drug abuse would produce increases in numerous substance-abuse problems, such as child abuse, domestic violence, and accidents. The duration of individual and social effects would depend on the severity of the oil-spill experience. Institutionally, communities would undergo considerable disruption and community conflict, with litigation constituting a secondary source of postspill social and community stress.

Conclusion: Effects on sociocultural systems are expected essentially to be the same as Alternative I (base case), in that one or more southern Kenai Peninsula communities would undergo periodic episodes of increased individual, social, and institutional stress and disruption that would last for several years in each instance and endure in memory for decades; effects are caused by both prelease and potential postlease processes and events.

l. **Effects on Archaeological and Cultural Resources:** This alternative would reduce effects on archaeological and cultural resources located in the deferral area, because it would lower the possibility of interaction from workers or the chance of contact from spilled oil. If a spill should occur, deferring the blocks west of LS 74 would offer some reduction in the chance of contact by removing some portion of the >5- and <25-percent 30-day summer-season estimated chance of contacting those land segments (Johnson et al., 1993). Deferring the blocks east of LS's 18 through 22 would offer some reduction in the chance of contact by removing some portion of the >5- and <25-percent 30-day summer-season estimated chance of contacting resources offshore and onshore in the area of those land segments (Johnson et al., 1993; Appendix B, Figs. B-16, B-17, and B-18). For Alternative VI, some (1-2%) reduction in the combined probabilities is shown for the following areas: the Alaska Peninsula from Hallo Bay north to include the Cape Douglas area (LS's 19, 21, and 22), Kalgin Island (LS 35), and Kachemak Bay and western Barren Islands (LS's 44 and 47) (Appendix B, Tables B-14 and B-15). The chance of contact from an oil spill during the summer season after 30 days would not be lowered from pipeline

Table IV.B.6.k-1
Alternative Distribution of Sale-Related Resident Population within the Kenai Peninsula Borough (KPB): Mid-Peninsula Area; Alternative VI

Year	Mid-Peninsula Total Resident Population without Sale	Sale-Related Resident Population	Mid -Peninsula Resident Population with Sale	Mid-Peninsula Percentage of Increase
1997	19,848	911	20,759	4.4
1998	20,027	673	20,700	3.3
1999	20,207	1,906	22,113	8.6
2000	20,389	2,895	23,284	12.4
2001	20,572	3,743	24,315	15.4
2002	20,757	3,222	23,979	13.4
2003	20,944	2,290	23,234	9.9
2004	21,133	2,304	23,437	9.9
2005	21,323	2,291	23,614	9.7
2006	21,515	2,291	23,806	9.6
2007	21,708	2,291	23,999	9.5
2008	21,904	2,291	24,195	9.5
2009	22,101	2,305	24,406	9.4
2010	22,300	2,343	24,643	9.5
2011	22,501	2,329	24,830	9.4
2012	22,703	2,315	25,018	9.3
2013	22,907	2,291	25,198	9.1
2014	23,114	2,290	25,404	9.0
2015	23,322	2,290	25,612	8.9
2016	23,531	2,291	25,822	8.9
2017	23,743	2,290	26,033	8.8
2018	23,957	2,291	26,248	8.7
2019	24,173	2,290	26,463	8.7
2020	24,390	2,290	26,680	8.6

Source: MMS, Alaska OCS Region.

and tanker segments and, therefore, the risk of effect would not be removed for LS's 68 through 74, 15 through 22, and 32 through 36. In Alternative VI, the effects of an oil spill would be lowered because the chance of occurrence and contact and, therefore, the risk of effect, would be reduced for LS's 74, 18 through 22, 35, 44, and 47. The effects would be lowered by an estimated 3 percent of the estimated 900 sites in the segments mentioned above, or 30 sites (Sec. IV.B.1).

Conclusion: It is estimated that this alternative would result in lowering the 3 percent of the resources (or 30 sites) disturbed by the effect factors under the base case, reducing the effects to <1 percent of the sites (an estimated 10 sites) in the land segments.

m. Effects on National and State Parks and Related Recreational Places: Deferral of the pollock-spawning area should reduce effects on resources of national and State parks and related recreational places located in the deferral area because it would lower the possibility of interaction from workers or the chance of contact from spilled oil. The field-development and infrastructure-construction activities associated with this alternative's assumed resources of 150 MMbbl of oil would result in effects not substantively different from those of the base case, in that effects due to area use by additional population and related infrastructure engendered by this alternative would be similar to those of the base case.

If a spill should occur, deferring the blocks west of LS 74 would offer some reduction in the chance of contact by removing some portion of the >5- and <25-percent 30-day summer-estimated chance of contacting those land segments (Johnson et al., 1993). Deferring the blocks east of LS's 18 through 22 would offer some reduction in the chance of contact by removing some portion of the >5- and <25-percent 30-day summer-estimated chance of contacting resources offshore and onshore in the area of those land segments (Johnson et al., 1993; Appendix B, Figs. B-16, B-17, and B-18). For Alternative VI, some (1-2%) reduction in the combined probabilities is shown for the following areas: the Alaska Peninsula from Hallo Bay north to include the Cape Douglas area (LS's 19, 21, and 22), Kalgin Island (LS 35), and Kachemak Bay and western Barren Islands (LS's 44 and 47) (Appendix B, Tables B-14 and B-15). The chance of contact from an oil spill during the summer season after 30 days would not be lowered contact from pipeline and tanker segments and, therefore, the risk of effect would not be removed for LS's 68 through 74, 15 through 22, and 32 through 36. In Alternative VI, the effects of an oil spill would be lowered because the chance of occurrence and contact and, therefore, the risk of effect, would be reduced for LS's 67 through 74, 18 through 22, 35, 44, and 47. The chance of contact and wear and tear from visitors and vandalism of the shore and intertidal zone habitats would be the same as in the base case.

Conclusion: It is estimated that this alternative would not result in a lowering of the population, infrastructure, or oil-spill-related effects of the base case. Less than 3 percent of the national and State parks and related recreational places would be affected for a period <3 years.

n. Effects on Air Quality: Air-quality regulations and procedures are discussed in Section IV.B.1.n, the base case. That discussion also describes the methodology used to model the air-quality effects associated with this proposed lease sale. The USEPA-approved OCD model was used to calculate the effects of pollutant emissions due to the proposal on onshore air quality. Because the Class I PSD areas allow for the least amount of degradation, the modeling scenario (i.e., source location) chosen for this analysis is the one that results in the maximum potential effect to the air quality of the designated national wilderness area of the Tuxedni National Wildlife Refuge, the only Class I area adjacent to the proposed sale area. The maximum-potential effect at any location in the Class II area would be the same. In all likelihood, effects to the Tuxedni National Wilderness Area would be lower than those calculated by the model.

For Alternative VI, peak-year emissions from exploration would be from drilling two exploration wells and two delineation wells from one rig. Peak-year emissions from development would include platform and pipeline installation and the drilling of 20 production wells from two rigs. Peak-year production emissions would result from operations (producing 13 MMbbl of oil), and transportation. Table IV.B.1.n-1 lists estimated uncontrolled-pollutant emissions for the peak-exploration, peak-development, and peak-production years. The USEPA-approved Offshore and Coastal Dispersion OCD model was used to calculate the effects of pollutant emissions due to the proposal on onshore air quality. Because the Class I PSD areas allow for the least amount of degradation, modeling for this proposal assumed maximum effect to the air quality of the designated national wilderness area of the Tuxedni National Wildlife Refuge, the only Class I area adjacent to the proposed sale area. However, due to the configuration of the deferral area, the sale area would be 13 km (8 mi) off of Chisik Island (within the national wilderness area of the Tuxedni National Wildlife Refuge, the only Class I area adjacent to the sale area). This is significant because the air-quality modeling assumed maximum effect to the air quality of the national wilderness area. Alternative VI provides a greater distance between the Class I area and the proposed action, thus reducing the already assessed minimal effect to air quality from the Alternative I base case.

Under the Federal and State of Alaska PSD regulations, because the estimated annual uncontrolled NO_2 emissions for peak-development year would exceed 250 tons per year, the lessee would be required to control NO_2 emissions through application of BACT to emissions sources to reduce NO_2 emissions (Table IV.B.1.n-2). The air-quality analysis performed using the OCD model for air pollutants emitted for exploration, development, and production under Alternative V showed that the maximum NO_2 concentration, averaged over a year, would be 0.19, 0.51, and 0.14 $\mu g/m^3$, respectively, at the shoreline; 7.6, 20.4, and 5.6 percent, respectively, of the available Class I increment for NO_2; and .76, 2.04, and .56 percent, respectively, for Class II. (Other pollutants also were modeled; however, NO_2 had the highest concentrations, which were well within PSD increments and air-quality standards.) The existing air quality would be maintained by a large margin.

For a more detailed discussion of the potential effects of air pollution—other than those effects addressed by standards—see Section IV.B.1.n. The amount of air pollutants reaching the shore is expected to be very low spatially and temporally because of the small amount of emissions from exploration, development, and production activities and their distance from shore. In addition, the probability of experiencing one or more blowouts in drilling the 40 wells projected for Alternative VI would be 8 to 11 percent. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore due to exploration and development/production or accidental emissions would not be sufficient to harm vegetation. A light, short-term coating of soot over a localized area could result from oil fires. Consequently, the effects of air-pollutant emissions under Alternative VI are expected to be minimal.

Conclusion: The effects associated with this alternative essentially would be the same, qualitatively, as those discussed for the Alternative I base case. Alternative VI provides reduction in air-quality effects to onshore resources due to the deferral of areas nearshore from potential exploration, development, and production activities. Effects on onshore air quality analyzed for Alternative VI are expected to be 20.4 percent of the maximum allowable PSD Class I increments. Only the Tuxedni National Wilderness Area is designated Class I, with the remaining area in and adjacent to the sale area designated Class II. Therefore, the potential effects would be much less. These effects would not make the concentrations of criteria pollutants in the onshore ambient air approach the air-quality standards. Consequently, a minimal effect on air quality with respect to standards is expected. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore from exploration, development, and production activities, and accidental emissions would not be sufficient to harm vegetation. A light, short-term coating of soot over a localized area could result from offshore oil fires.

o. Effects on Coastal Zone Management: The Pollock-Spawning Area Deferral Alternative would remove all blocks south of the Kennedy Entrance (the area includes the Barren Islands and Cape Douglas). Removing this area reduces effects on nonendangered marine mammals, especially sea otters along the western shore of Shelikof Strait. However, none of the reductions is of a magnitude to reduce overall levels of effects.

Because activities occurring in the base-case scenario also are assumed for this scenario and levels of effects of oil spills on biological resources remain comparable to the base case, potential conflict with the Statewide standards and district policies of the ACMP would be comparable to those in the base case. Statewide standards and district policies of the ACMP covered in the base-case analysis include coastal development; geophysical-hazard areas; recreation; energy facilities; transportation and utilities; fish and seafood processing; subsistence; habitats; air, land, and water quality; and historic, prehistoric, and archaeological resources. Potential conflict with many of these Statewide standards and the associated district policies often is unknown until a specific plan is submitted; however, a potential for conflict was identified with the habitat standard. The ACMP provides a format for mitigating potential conflicts. The MMS operating procedures and the mitigating measures associated with this sale—especially the ITL clauses for Oil-Spill-Contingency Response, Bird and Marine Mammal Protection, Sensitive Areas to be Considered in Oil-Spill Contingency Plans, Coastal Zone Management, and the stipulations on Density Restriction Related to Commercial Fishing Uses, and Minimizing Potential Conflicts Between Oil and Gas Industry and Fishing Activities—provide additional mechanisms to ensure that activities that may follow this sale avoid conflict with the ACMP.

Conclusion: As in the base case, potential conflict with the habitat standard of the ACMP and district policies is possible. Site-specific information is necessary to ensure there is no conflict with the policies related to coastal development; geophysical hazards; energy-facility siting; transportation and utilities; subsistence; air, land, and water quality; and historic, prehistoric, and archaeological resources. Conflict is not inherent in the scenario.

7. Alternative VII, General Fisheries Deferral Alternative:

Description of Alternative VII: The General Fisheries Deferral would offer for leasing 217 blocks, about 917, 236 acres, in the central portion of the proposed sale area. This area comprises approximately 46 percent of the acreage offered by Alternative I (Figure II.G.1). The acreage offered for deferral by this Alternative is similar in extent and purpose to that of Alternative V, except that the deferred area is more extensive and offers a greater degree of protection to area fisheries.

The resources assumed for analysis located in this Alternative are expected to equate to 20 percent of the proposal, about 80 MMbbl of oil. Because of the level of resources forecast for this Alternative and the economic considerations associated with development of hydrocarbons in the lower Cook Inlet, it is not expected that Alternative VII would produce commercially recoverable quantities of hydrocarbons. Accordingly, an exploration-only scenario is analyzed for this alternative. One or two exploration wells will be drilled from a single drilling rig within 2 years of the sale date after which, activity will cease (please refer to Table II.A.2).

a. Effects on Water Quality:

For Alternative VII, the activities associated with petroleum exploitation most likely to affect water quality in the CI/SS area are the permitted discharges from exploration-drilling units. Selecting the General Fisheries Deferral Alternative would reduce the economically recoverable oil resources assumed for analysis from 200 MMbbl (Alternative I base case) to an assumed 80 MMbbl. If only this amount is discovered, 80 MMbbl is too small a quantity to be economically recoverable for the foreseeable future, and only exploration activities would be conducted in the sale area. The types of activities associated with this alternative are the same as for Alternative I (low case, Sec. IV.B.8.a); the levels of activities compared to Alternative I (low case) are shown in Table IV.A.1. The characteristics of the discharges and activities and their potential effects on water quality are described for Alternative I, base case (Sec IV.B.1.a), and specifically for Alternative I (low case—exploration only) (Sec. IV.B.8.a) and summarized in this section.

The benefits of the deferral alternative are derived from (1) a reduced level of drilling activities associated with exploration and (2) the exclusion of exploration-drilling units and production platforms from locating in the deferred areas—about 46 percent of the Sale 149 Call area; these areas are shown in Figure II.G.I. Compared to Alternative I (base case), the reduced level of drilling activities would result in a decrease in the amount of material discharged into the waters of Cook Inlet. Based on information from Table IV.B.1.a-2, the discharges would be reduce by about (1) 89 to 96 percent for drilling muds and (2) 97 percent for cuttings; there would be no production-related discharges. Excluding the drilling units from the deferred areas eliminates the direct release of the permitted discharges into the waters of these areas.

The hydrodynamic processes in the Cook Inlet Planning Area suggest the water column generally is well mixed, and dilution would reduce the concentration of the substances in the discharges. Degradation processes also act to continuously reduce the concentrations of many substances deliberately or accidentally released into the environment.

Of the permitted discharges, drilling muds and cuttings are among the more significant discharges associated with offshore exploration operations. This analysis will consider (1) the chronic criterion (for the protection of marine life) for SPM/turbidity to range from 100 to 1,000 mg/l (Sec. IV.B.1.a(1)(a)1)). The permitted discharges would add substances that may be foreign to or increase the concentration of constituents already present in the water column of CI/SS. In general, the added substances may cause sublethal effects in some marine organisms if concentrations are greater than the chronic criteria and lethal effects if concentrations are greater than the acute criteria.

Drilling of the two exploration wells could result in the discharge of an estimated 720 tons (dry weight) of drilling-mud components and 880 tons (dry weight) of cuttings (Table IV.B.1.a-2). The concentrations of discharged drilling muds initially may range from about 1,000 to 2,000 g/l and are expected to be greater than the SPM/turbidity chronic criteria, 100 to 1,000 mg/l assumed for this analysis. However, within about 100 to 200 m of the discharge point, mixing in the water column would reduce the concentrations by a factor of 10,000 to 1,000,000; the diluted concentrations are estimated to range from 1 to 200 mg/l. The concentration of SPM in lower Cook Inlet and Shelikof Strait ranges from about 1 to 50 mg/l. Most of the solids in the discharges settle rapidly to the seafloor, where bottom currents disperse the finer particles. For Alternative VII (as shown in Table IV.B.1.a-2), the drilling muds discharged into Cook Inlet would contain a total estimated 268 tons of barium, < 1 lb of mercury, and about 3 lb of cadmium. The drilling discharges are expected to take place over a 1- to 2-year period. As noted in Section III.A.5.b, Cook Inlet streams and rivers annually may discharge at least (1) 149 to 486 tons of barium, (2) 1,102 to 2,563 lb of mercury, and (3) 11,018 to 25, 631 lb of cadmium.

The characteristics of the other exploration-related discharges are expected to be within the USEPA criterion and/or be diluted in the water column within an area <2 km^2 to background concentrations or levels that would not cause sublethal to lethal effects in marine organisms.

The potential effects in any of the areas where there are permitted discharges would last for about 2 to 3 months for each exploration well drilled. Future procedures and technologies for treating and handling drilling muds and cuttings may reduce or eliminate discharges directly into the marine environment.

The discharge of drilling muds and cuttings and other discharges associated with exploration drilling are not expected to have any effect on the overall quality of the Cook Inlet water. Within a distance of between 100 and 200 m from the discharge point, the turbidity caused by SPM in the discharged muds and cuttings is expected to be diluted to levels that are less than the chronic criteria (100-1,000 mg/l) and within the range associated with the variability of naturally occurring SPM concentrations. Mixing in the water column would reduce the toxicity of the drilling muds which, in general, are practically nontoxic, to levels that would not be harmful to organisms in the water column. In general, the amounts of additives in the other discharges are expected to be relatively small (from 1 to 100 or 200 g/month) and diluted with seawater several hundred to several thousand times before being discharged into the receiving waters.

Conclusion: The overall quality of Cook Inlet water would not be affected by this alternative and would remain good (unpolluted).

b. Effects on Lower Trophic-Level Organisms: Routine activities associated with the General Fisheries Deferral Alternative (Alternative VII) that may affect lower trophic-level organisms include seismic surveys, drilling discharges, and dredging or construction. There are no production activities associated with this alternative. The effects of these activities on lower trophic-level organisms are discussed in the base case (Sec. IV.B.1.b) and are summarized below. The following analysis for Alternative VII focuses on the differences in the amount of activity (the only variable) estimated for Alternative VII, as compared to that of the base case. It then estimates the resulting effect of this difference on lower trophic-level organisms for Alternative VII.

Alternative VII involves exploration only and would delete 217 partial and whole blocks, or about 46 percent of the sale area discussed in the base case. This would eliminate any OCS activity in the deferral areas. Concerning the remainder of the sale area, Alternative VII estimates less drilling activity (2 wells) than the base case (56 wells). This reduction is expected to reduce effects on lower trophic-level organisms to about 5 percent of the base case. Drilling discharges in the base case are estimated would have sublethal effects on <1 percent of the benthic organisms in the sale area and none of its plankton. Recovery is expected to occur within 1 year. Construction activities associated with Alternative VII also are expected to be only a fraction of those expected for the base case and are expected would have little to no effect on plankton communities. Seismic surveys are expected to have little to no effect on lower trophic-level organisms.

Conclusion: Routine activities associated with alternative VII are estimated to have mostly sublethal effects on about half of the lower trophic-level organisms estimated for the base case (<1% of those in the sale area). The recovery of benthic organisms from drilling discharges is expected within 1 year after they cease.

c. Effects on Fisheries Resources: This alternative (General Fisheries Deferral) removes lease blocks from the sale area that are adjacent to fisheries-resource areas, creating large buffer zones. The size of these buffer zones likely renders the sale area uneconomic for oil development, so this analysis is for exploration only.

The primary factors that may have deleterious effects on finfishes in the sale area under the General Fisheries Deferral are noise and other disturbance associated with exploration (seismic activities and marine and aircraft traffic) and habitat loss and/or alteration. This analysis considers the potential effects of these factors on fisheries resources. Marine and logistics support would be from the Kenai-Nikiski area, with air support from Kenai-

Nikiski area or Homer. Effects on fisheries resources due to (1) oil spills and oil pollution, (2) noise and disturbance, and (3) habitat loss and/or alteration have been analyzed and appear in full under the base case (Sec. IV.B.1.c).

The protection to fish resources afforded by this deferral would be minimal at the population level. This is because the effects of oil spills associated with oil exploration and development generally are minimal for fish resources.

Fisheries resources (pelagic, semidemersal, and demersal fish species) could be disturbed and displaced from the immediate vicinity of drilling discharges, within a radius probably not to exceed 100 m. There would be no effect on mobile pelagic and semidemersal fishes, and the effects on demersal fishes very likely would be limited to only the short time periods of the discharge. Offshore construction also could temporarily disturb and/or displace fisheries resources. Any disturbance or displacement should be short term (hours to days), limited to only the time of construction and shortly thereafter. Though seismic surveys may damage eggs and larvae of some fishes, this injury is limited to within a meter or two from the airgun-discharge ports. Thus, seismic surveys probably would have no appreciable adverse effects on fish populations.

In summary, the estimated spill effects under the general fisheries deferral are eliminated, because this deferral would limit lease activities to exploration only. The short-term, local effects of noise, disturbance, and habitat alterations from exploration activities such as drilling discharges, seismic noise, and construction activities would be minimal.

Conclusion: The general fisheries deferral eliminates the potential effects of an oil spill to finfishes. Exploration activities such as drilling discharges, offshore construction, and seismic surveys have minimal effects on finfish populations in the lower Cook Inlet. Therefore, the general fisheries deferral will have minimal effects on fish resources.

d. Effects on Marine and Coastal Birds: The General Fisheries Deferral Alternative would remove approximately 217 whole and partial lease blocks (46.41% of the sale area) from the sale area, leasing only those blocks in the central most part of the lower Cook Inlet planning area. This alternative would provide a buffer zone (about 6-20 mi wide) along the coast of lower Cook Inlet and northern Shelikof Strait, including important habitats of marine and coastal birds. Only oil exploration is assumed to occur under this alternative. The primary adverse effects on marine and coastal birds under Alternative VII is expected to come from noise and disturbance of bird populations.

Noise and Disturbance Effects from Exploration Activities: For Alternative VII exploratory drilling, only one drilling unit is expected to be used each year at one time. Platform-installation activities associated with exploration temporarily could displace (one season) several birds near (within about 1 mi) the platform-installation site. Some brief (perhaps a few minutes to <1 hour) displacement of birds could occur because of noise and movement of aircraft traffic (30-60 helicopter flights/month) between the city of Kenai and the drill platform in lower Cook Inlet area and due to boat traffic (15-30 supply boats/month) between the drill platform and a marine-support facility in Kenai. These effects are expected to be local (within about 1 mi of the air- and boat-traffic routes), and disturbance of birds along these traffic routes is expected to be short term (a few minutes to <1 hour for aircraft and boat disturbance of birds and one season or about 3-months' displacement of some birds [probability less than a few hundred] within <1 mi of the platform site during installation activities).

The analysis assumes that the oil industry and its contractors would comply with the ITL on Bird and Mammal Protection and avoid flying within 1 mi of seabird colonies and known bird-concentration areas. This compliance is expected to prevent excessive or frequent disturbance of seabird colonies and waterfowl and shorebird nesting and feeding concentrations.

On some occasions when weather and visibility are poor, support-helicopter flights and marine-vessel trips are expected to unavoidably disturb some (perhaps a few hundred to a few thousand) seabirds, waterfowl, and shorebirds. This would result in the temporary displacement (a few minutes to <1 hour) of seabirds at a colony site or on the water or waterfowl and shorebirds on the water or on a coastal habitat. Any possible losses of young birds or eggs (perhaps ≤100) and reduced survival of some adult birds is expected to be short term, with recovery occurring within one generation.

Under this alternative, the effects of potential aircraft (30-60 flight/month) and marine-vessel (15-30 trips/month) noise and disturbance on marine and coastal birds are expected to be short term (a few minutes to < 1 hour for aircraft and vessel-caused disturbances), intermittent over the 2 or 3 years of exploration, and local—within 1 mi of the exploration platform—along the traffic route to and from the Kenai airport and involve perhaps a few thousand birds. The loss of < 100 young birds and/or eggs is expected from aircraft-caused disturbances (assuming the disturbance occurs at seabird colonies), with recovery occurring within < 1 one generation, or ≤ 1 or 2 years. This alternative is expected to avoid the potential oils spill effects associated with the proposal, Alternative I because only exploration is assumed to occur and no oil spills are expected to occur.

Conclusion: The overall effect of Alternative VII on marine and coastal birds is expected to include the loss of very small numbers of birds or their eggs (such as < 100 individuals), with recovery occurring within less than one generation, and no population effects on marine and coastal birds are expected to occur. This alternative is expected to greatly reduce the effects of the proposal, Alternative I because no oil spills are expected to occur.

e. **Effects on Nonendangered Marine Mammals (Pinnipeds, Cetaceans, and the Sea Otter):** This deferral alternative removes lease blocks from the sale area that are important to fisheries. The primary factors that may have deleterious effects on marine mammals in the sale area under the General Fisheries Deferral Alternative are noise and other disturbance associated with exploration (seismic activities and marine and aircraft traffic) and habitat loss and/or alteration. This analysis considers the potential effects of these factors on individual pinnipeds, cetaceans, and sea otters.

The General Fisheries Deferral Alternative assumes no oil spills or direct oil contact on marine mammals. Under this alternative, remaining oil reserves after the deferral are considered too low to be produced. Therefore, this alternative is for exploration only.

(1) **Effects of Noise and Disturbance on Marine Mammals:** Noise and disturbance activities that may affect marine mammals in the proposed sale area include geophysical surveys, marine dredging and construction, support vessels, aircraft overflights, and offshore drilling and production. Marine mammal population vulnerability to disturbance depends on several factors, including (1) the number of animals involved, (2) sensitivity of the species, (3) the presence of preferred habitat in relation to the disturbance, and (4) the characteristics of the disturbance source. The loudest noise source created by industry activity was identified as seismic noise. Sounds generated by seismic surveys are below the "most sensitive range" for pinnipeds and probably would not affect harbor and fur seal activities. Sea otters indicated no reaction to seismic noise from either a full array or single airgun. Effects on the minke whale have not been studied but likely would be similar to effects on other baleen whales. Baleen whales generally are tolerant of seismic pulses. Subtle behavioral changes may occur on occasion at low-sound levels, with stronger avoidance reactions when sound levels reach 160-170 dB, or higher. Toothed-whale hearing appears poor at frequencies lower than 1 kHz, where most industrial sounds and seismic pulses are produced.

Aircraft overflights can be another potential source of disturbance. Pinniped response to low-altitude aircraft can result in stampede or flight into the water. This may increase pup mortality during the pupping season. Both baleen and toothed whales usually respond to low overflights by diving. Reactions of pinnipeds and cetaceans vary by aircraft type, altitude of flight, and circumstances of the animals. These disturbance reactions usually are short term, with seals reoccupying haulouts and whales continuing their activities usually within a matter of hours. For a complete discussion of the potential effects of noise and disturbance to marine mammals, including the effects of geophysical noise, marine dredging and construction, support vessels, and aircraft overflights, see Section IV.B.1.e(5).

(2) **Effects of Habitat Loss and/or Alteration on Marine Mammals:** Habitat loss and/or alteration would be limited to temporary disturbance to pinnipeds and cetaceans in the offshore environment associated with erection of an exploration platform. Such activities may cause pinnipeds and cetaceans to forage in less suitable habitat or areas with lower prey availability. This disturbance likely would be relatively short term and very localized (on the order of hours to days, within about 1 km^2).

Effects from Drilling Discharges: Trace metals in marine organisms are similar to levels for animals in the Gulf of Alaska (Burrell, 1978). Petroleum hydrocarbons were detected only in organisms near the Homer boat harbor (Shaw, 1981). Thus, the flushing rate and tidal flux of Cook Inlet have worked to keep the Inlet relatively free of contaminants that may affect water quality. Drilling discharges added to the sale area by postlease activities may contribute additional heavy metals but are not expected to significantly affect water quality and have an effect on marine mammals. (See Secs. III.A.5 and IV.B.1.a on Water Quality.)

Conclusion: Compared to the base case, there would be no oil-spill-associated mortality under this deferral alternative. Disturbance from aircraft overflights and habitat alteration/construction activities would be relatively short term and very localized, with seals reoccupying haulouts and whales continuing their activities usually within a matter of hours. Seismic noise associated with exploration is expected to have minimal effects on marine mammals. None of the activities is expected to affect marine mammal survival.

f. Effects on Endangered and Threatened Species: Alternative VII (General Fisheries Deferral) would provide a buffer extending between 6 and 18 mi offshore around most of lower Cook Inlet and the Cape Douglas area. However, only those deferred lease blocks just northwest of the Barren Islands and near Cape Douglas, and possibly those west of the southern Kenai Peninsula, lie within a zone of probable seasonal occurrence of endangered whale species, areas potentially used by foraging or rafting Steller sea lions from the major Barren Islands rookery and peripheral haulouts, and adjacent to probable Steller's eider wintering habitat (Graphic 3). Nevertheless, this alternative removes approximately 50 percent of the limited southern and southeastern sale area within which, under Alternative I (proposal, Sec. IV.B.1.f), a small proportion of these species' populations potentially could be exposed to routine exploration activities.

For these populations, the most likely sources of adverse effects associated with this exploration alternative are disturbance (including drilling operations, aircraft and vessel traffic, and seismic surveys), and release of drilling muds and cuttings. The buffer created by removing lease blocks from the sale area would be expected to reduce effects of exploration activity somewhat in these areas as a result of the greater distance between potential platform sites and wildlife concentrations. However, as discussed for Alternative I, potential effects from exploration activities already are likely to be minimal because of the expectation that travel routes of few whales or sea lions will intersect those of vessels or aircraft, or approach a platform, and that any interaction effects (e.g., travel direction change, area avoidance) will last for less than an hour. Likewise, exposure of whales or sea lions, or their prey species, to any materials released into the environment is expected to have minimal effects due to rapid dispersal of such materials to nontoxic concentrations in this oceanographically dynamic area.

The principal result of this exploration-only alternative would be to eliminate the potential effects that could result from incidents or activities associated with development and production as discussed under Alternative I, including: (1) an oil spill; (2) additional potential disturbance from platform construction, operation and supply, and pipeline construction; and (3) release of additional drilling muds and cuttings. Because of their virtual absence from the sale area, no endangered or threatened bird populations are expected to be affected by exploration or development/production activities. Wintering Steller's eiders occupy coastal areas mainly west and south of the sale area and thus are not likely to be affected by exploration activities.

In summary, the General Fisheries Deferral Alternative is expected to reduce potentially disturbing activities and minor contaminants to near minimal levels in buffer areas that constitute approximately 50 percent of the limited portion of the sale area where small numbers of endangered whales and Steller sea lions may occur. As a result, a limited reduction of potential effects to these populations from those expected under Alternative I exploration likely would occur.

Conclusion: The overall effect of this exploration alternative on endangered whales and Steller sea lions is expected to be somewhat less than the minimal effect determined under Alternative I exploration and significantly less than the entire proposed action.

g. Effects on Terrestrial Mammals: Alternative VII would remove approximately 217 whole and partial lease blocks (46.41% of the sale area) from the sale area, leasing only those blocks in the centralmost part of the planning area. Alternative VII, the General Fisheries Deferral Alternative, would provide a buffer zone (about 6-20 mi wide) along the coast of lower Cook Inlet and northern Shelikof Strait, including important coastal habitats of brown bears, river otters, and other terrestrial mammals. Only oil exploration is assumed to occur under this alternative. The primary effects of exploration-only scenario on brown bears, river otters, Sitka black-tailed deer, and other terrestrial mammals are expected to come from noise and disturbance associated with air-support traffic and, to a lesser extent, marine-support-vessel traffic.

Effects of Noise and Disturbance: For Alternative VII exploratory drilling, only one drilling unit is expected to be used each year. Some brief displacement (perhaps a few minutes to < 1 hour) of brown bears and other terrestrial mammals is expected to occur because of noise and movement of aircraft traffic (30-60 helicopter flights/month or 1-2/day) to and from the Kenai/Nikiski area and the exploration drill platform assumed to be located in the lower Cook Inlet area, and from boat traffic (15-30 supply boats/month). Vessel traffic would be only a potential source of disturbance of terrestrial mammals near or within about 1 mi of the assumed marine-support facility in the Kenai/Nikiski area. These effects are expected to be local, within about 1 mi of that portion of the aircraft-traffic route that passes over land between the support facility and the offshore-drill platform in lower Cook Inlet within about 1 mi of the Kenai airport. Disturbance of bears, river otters, deer, and other terrestrial mammals along the air-traffic route and near the marine facility is expected to be short term, a few minutes to an hour, or less. Because no oil spills are expected under the Alternative VII exploration-only scenario, no mortality of terrestrial mammals is expected to occur.

Conclusion: The overall effect of Alternative VII on terrestrial mammals is expected to include the displacement of very small numbers (< 10) of brown bears, river otters, or other terrestrial mammals within 1 mi of the airport and marine facility in the Kenai/Nikiski area or along traffic routes nearshore. This alternative is expected to greatly reduce the potential effects of the proposal, because no oil spills and thus no mortality is expected to occur; populations of terrestrial mammals are not expected to be affected.

h. Effects on the Economy: Increased employment is the most significant economic effect generated by Alternative VII, the General Fisheries Deferral Alternative. Employees would work on the construction, operation, and servicing of two exploration wells and one shore base. Effects from Alternative VII would be only a small amount of employment for 2 years on the western side of the Kenai Peninsula. The number of direct OCS workers needed for the two exploration wells and construction of a portion of a shore base would be 197 in 1997 and 97 in 1998. This change in employment and the construction of limited shore-base facilities translates to a change in resident income, local prices, and local taxes of < 1 percent for < 3 years. With respect to spills, there essentially would be no economic effects.

Conclusion: Alternative VII would generate changes substantially less than the base case. These changes would be a < 1-percent increase in resident employment, resident income, local prices, and local taxes in the KPB annually for < 3 years.

i. Effects on Commercial Fisheries: Activities associated with the General Fisheries Deferral Alternative (Alternative VII) that may affect the commercial-fishing industry in Cook Inlet include drilling discharges, offshore construction and seismic surveys. There are no production activities associated with this alternative. The effects of these activities on the Cook Inlet commercial-fishing industry are discussed in the base case (Sec. IV.B.1.i) and are summarized below. The following analysis for Alternative VII focuses on the differences in the amount of activity (the only variable) estimated for Alternative VII, as compared to that of the base case. It then estimates the resulting effect of this difference on the Cook Inlet commercial-fishing industry for Alternative VII.

Alternative VII involves exploration only and would delete 217 partial and whole blocks, or about 46 percent of the sale area discussed in the base case. This would eliminate any OCS activity in the deferral areas, thereby reducing the overall effect of drilling discharges, offshore construction, and seismic surveys associated with Alternative VII to about half that of the base case. However, drilling discharges associated with the base case are not expected to have an effect on commercial fishing due to the limited area affected near the platform-discharge point. Offshore construction, platforms, and pipelines, are expected to result in some space-use conflicts for the base case (e.g., competition for docking space or gear loss); however, these are expected to be few in number and minor in scope. Seismic surveys, planned and coordinated with the commercial-fishing industry, also are expected to have a minimal effect on the Cook Inlet commercial-fishing industry. Hence, Alternative VII is expected to reduce the effect of drilling discharges, offshore construction, and seismic surveys in the base case by about one half.

Conclusion: The General Fisheries Deferral Alternative is expected to reduce the effect of drilling discharges, offshore construction, and seismic surveys in the base case by about one half.

j. Effects on Subsistence-Harvest Patterns: Potential effects-producing factors include routine operations such as seismic surveys, the disposal of drilling muds and cuttings, and construction and other support activities. An exploration-only approach is used in the General Fisheries Deferral Alternative, with the conclusion after a 2-year period of exploration that there are no likely economically producible hydrocarbon resources available. Two exploratory wells are drilled from a single drilling platform during this period. Site-specific seismic surveys carried out prior to drilling could cause some disturbance to fish, marine mammals, marine and coastal birds, and marine invertebrates during open-water periods; discharged muds and cuttings also could produce effects on marine resources (see Sec. IV.B.7.b-g for discussions of Alternative VII effects on marine resources). Such localized and short-term effects on subsistence resources should have limited effects on community subsistence-harvest patterns and should not cause measurable changes in the availability or accessibility of subsistence resources.

A limited level of support and logistic activities are estimated to take place from existing air and marine facilities on the Kenai Peninsula and, therefore, such use of these facilities should not measurably increase the levels of effects on subsistence resources and harvests. Supply-boat and helicopter trips between these facilities and the exploration rig could interfere with subsistence harvests as a result of disturbance, but such events should be localized and subject to mitigation if consistently encountered.

Conclusion: Effects on subsistence-harvest patterns in the General Fisheries Deferral Alternative are expected to be localized, of short-term duration, and not of such an extent to create measurable changes in the availability or accessibility of subsistence resources.

k. Effects on Sociocultural Systems: Section III.C.4 describes the sociocultural systems for those communities in Southcentral Alaska that could be affected by the proposed lease sale. The analysis that follows takes into account effects from planning processes; routine activities that may result from the sale, such as the introduction of industrial activities and changes in community population levels; and potential effects on subsistence-harvest patterns.

Effects on sociocultural systems begin with the prelease processes of announcing the proposed sale and carrying out the preparation of an EIS. This sometimes lengthy process would cause stress and anxiety among affected publics. The discussion under the base case (Sec. IV.B.1.k.) explores the types of impacts involved.

An exploration-only approach is used in Alternative VII, the General Fisheries Deferral Alternative. Two exploratory wells are drilled from a single drilling platform, with the conclusion after a 2-year period of exploration that there are no economically producible hydrocarbon resources available. A limited level of support and logistic activities are estimated to take place during this time from existing air and marine facilities on the Kenai Peninsula. Table IV.B.7.k-1 shows a 1.3- to 2.7-percent increase in resident population during these exploratory years. There would be no change in the resident population of the Kenai Peninsula in other years as a result of the lease sale under this alternative.

The limited level of support and logistic activities estimated to take place from existing air and marine facilities on the Kenai Peninsula is not expected to measurably increase the levels of effects on subsistence resources and harvests from these facilities. Therefore, there should be little or no sociocultural effect from the effects of exploration activities on subsistence harvests.

Conclusion: Affected publics in one or more southern Kenai Peninsula communities would undergo increased individual, social, and institutional stress and disruption during the prelease-planning process. Otherwise, little or no effects on sociocultural systems are expected in the General Fisheries Deferral Alternative.

l. Effects on Archaeological and Cultural Resources: The activities that would produce effects on archaeological and cultural resources are exploration activities, marine- and logistics-support activities, and air-support activities from a support base on the western side of the Kenai Peninsula.

The largest effects would come from vandalism, because more people would know about the location and would be present at the sites. That knowledge would increase as the population and activities increase. A second type of effect, resulting directly from cleanup work, would not be applicable if no oil were found. The effects on environmental resources in the Cook Inlet sale area would be similar in type to those of base-case-exploration

Table IV.B.7.k-1
Alternative Distribution of Sale-Related Resident Population within the Kenai Peninsula Borough (KPB): Mid-Peninsula Area; Alternative VII

Year	Mid-Peninsula Total Resident Population without Sale	Sale-Related Resident Population	Mid-Peninsula Resident Population with Sale	Mid-Peninsula Percentage of Increase
1997	19,848	541	20,389	2.7
1998	20,027	266	20,293	1.3
1999	20,207	0	20,207	0.0
2000	20,389	0	20,389	0.0
2001	20,572	0	20,572	0.0
2002	20,757	0	20,757	0.0
2003	20,944	0	20,944	0.0
2004	21,133	0	21,133	0.0
2005	21,323	0	21,323	0.0
2006	21,515	0	21,515	0.0
2007	21,708	0	21,708	0.0
2008	21,904	0	21,904	0.0
2009	22,101	0	22,101	0.0
2010	22,300	0	22,300	0.0
2011	22,501	0	22,501	0.0
2012	22,703	0	22,703	0.0
2013	22,907	0	22,907	0.0
2014	23,114	0	23,114	0.0
2015	23,322	0	23,322	0.0
2016	23,531	0	23,531	0.0
2017	23,743	0	23,743	0.0
2018	23,957	0	23,957	0.0
2019	24,173	0	24,173	0.0
2020	24,390	0	24,390	0.0

Source: MMS, Alaska OCS Region.

activities. Leasing activities may affect onshore resources, even if no oil were found. Prehistoric archaeological sites may be lost through looting and indiscriminate or accidental activity on known and currently unknown sites. State archaeological analysis (AHRF, 1993) has shown that prehistoric and historic archaeological resources exist within the onshore area that could be disturbed, resulting in some loss of data.

Conclusion: The effects of Alternative VII, the General Fisheries Deferral Alternative, on archaeological and cultural resources is estimated to be ≤1 percent of the archaeological sites and cultural resources and would be due to exploration activities and indiscriminate contact of exploration personnel with archaeological sites.

m. Effects on National and State Parks and Related Recreational Places: I Resources in national and State parks and related recreational places are abundant and of high quality (see Sec. III.C.6). Drilling rigs and platforms can directly affect public perceptions of coastal and nearshore seascape views. Indirectly, rigs, platforms, and transportation vessels are associated with oil spills and marine trash and debris, which also can adversely affect the aesthetics of the marine environment or coastal shore.

For the Alternative VII, only one platform would be used for exploration. However, platforms easily can be seen by passengers on planes flying over them. Set against the background of mountains and volcanoes, some of the platforms or their replacements have been in view for over 15 years, since drilling started in the area. The one new offshore rig and platform 10 or more miles out from shore may be barely perceptible from shore in the fairest of weather conditions, and it would be indistinguishable from objects such as ships or tankers and unlikely to spoil natural shorefront vistas Platforms within 12 mi would, however, be a part of the viewing environment, and all platforms would be a part of the viewing environment of passengers on planes flying near them. For example, there are approximately 30 air flights per day between Anchorage and cities of the Kenai Peninsula and Kodiak on common carriers. Private aircraft make numerous special flights. Some tourism operatives have "flightseeing" trips over glaciers and volcanoes in the area. New platforms, rigs, or flares would have some effect on the view, because they change the viewscape. Visitor rates would be reduced only minimally. A decline in spending by visitors would be in proportion to the decline in the number of visitors.

Most other effects on the resources would be due to changes in the numbers of users. The base case estimates that a small increase (197 workers in 1997 and 97 workers in 1998) is expected due to proposed exploration activities (see Sec. IV.B.1.h, Economy). This small increase in potential recreational resource users would not place serious stress on the parks.

Conclusion: Effects on national and State parks and related recreational places would be from activities of exploration personnel and other indirect increases in population brought on by exploration activities. Effects on Alaska Peninsula resources could be from additional overcrowded recreational and tourism facilities. Effects of this alternative on national and State parks and related recreational places could reduce visual qualities from long distances very slightly and reduce visitor rates minimally. A decline in spending by visitors would be in proportion to the decline in the number of visitors.

n. Effects on Air Quality: Air-quality regulations and procedures are discussed in Section IV.B.1.n, the base case. That discussion also describes the methodology used to model the air-quality effects associated with this proposed lease sale. The EPA-approved OCD model was used to calculate the effects of pollutant emissions from the proposal on onshore air quality. Because the Class I PSD areas allow for the least amount of degradation, the modeling scenario (i.e., source location) chosen for this analysis is the one that results in the maximum-potential effect to the air quality of the designated national wilderness area of the Tuxedni National Wildlife Refuge, the only Class I area adjacent to the proposed sale area. The maximum-potential effect at any location in the Class II area would be the same. In all likelihood, effects to the Tuxedni National Wilderness Area would be lower than those calculated by the model.

For Alternative VII, there would be exploration only with no oil development due to the assumed small amount of discovered oil (40 MMbbl). Emissions from the peak-exploration year would be similar to those for the base case. Please see Table IV.B.1.n-1 for a listing of estimated uncontrolled-pollutant emissions for the peak-exploration years. Under the Federal and State of Alaska PSD regulations, a PSD review would not be required. However, a permit still would be required and the source would have to meet any applicable performance requirements set by the State of Alaska. The OCD model air-quality analysis for air pollutants emitted for exploration under Alternative VII estimated that the maximum NO_2 concentration, averaged over a year, would be 0.19 at the shoreline—7.6 percent of the available Class I increment for NO_2 and .76 for Class II. (Other pollutants also were modeled; however, NO_2 had the highest concentrations, which were well within PSD increments and air-quality standards.)

<u>**Other Effects on Air Quality**</u>: Air-pollutant levels reaching the shore are expected to be very low spatially and temporally because of the small amount of emissions from exploration activities and their distance from shore. Consequently, the effects of air-pollutant emissions in Alternative VII—other than with respect to standards—are expected to be minimal.

<u>**Conclusion**</u>: The effects associated with this alternative essentially would be the same, qualitatively, as those discussed for the Alternative I base case. Assuming exploration only in Alternative VII, effects on onshore air quality analyzed are expected to be 7.6 percent of the maximum allowable PSD Class I increments. Only the Tuxedni National Wilderness Area is designated Class I, with the remaining area in and adjacent to the sale area designated Class II. Therefore, the potential effects would be much less. These effects would not make the concentrations of criteria pollutants in the onshore ambient air approach the air-quality standards. Consequently, a minimal effect on air quality with respect to standards is expected. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore from exploration, development, and production activities, and accidental emissions would not be sufficient to harm vegetation.

o. <u>Effects on Coastal Zone Management</u>: Conclusions for biological resources in Section IV.B.7 indicate that this alternative, the General Fisheries Deferral Alternative, could provide localized reduction in oil-spill risk for important coastal habitats in Cook Inlet and northern Shelikof Strait. Effects on subsistence are not expected to be reduced significantly. Statewide standards and associated district policies assessed in the base case include coastal development; geophysical-hazard areas; recreation; energy facilities; transportation and utilities; fish and seafood processing; subsistence; habitats; air, land, and water quality; and historic, prehistoric, and archaeological resources. Potential conflict with many of these Statewide standards and the associated district policies is unknown until a specific plan is submitted. However, a potential for conflict with the Statewide habitat standard was identified in the base case. Conflict resulted from the effects of seismic activities and oil spills in the offshore environment on commercial fishing. The ACMP provides a format for mitigating these potential conflicts. The MMS operating procedures and the mitigating measures associated with this sale—especially the ITL clauses for Oil-Spill-Contingency Response, Bird and Marine Mammal Protection, Sensitive Areas to be Considered in Oil-Spill-Contingency Plans, Coastal Zone Management, and the stipulations on Density Restriction Related to Commercial Fishing Uses, and Minimizing Potential Conflicts Between Oil and Gas Industry and Fishing Activities—provide additional mechanisms to ensure that activities that may follow this sale avoid conflict with the ACMP.

<u>**Conclusion**</u>: Potential conflict with the Statewide standard on habitats is possible. Site-specific information is necessary to ensure there is no conflict with the policies related to coastal development; geophysical hazards; energy-facility siting; transportation and utilities; subsistence; air, land, and water quality; and historic, prehistoric, and archaeological resources. Conflict is not inherent in the scenario.

8. Alternative VIII, Northern Deferral Alternative:

Description of Alternative VIII: This alternative would offer for leasing 285 blocks (1.44 million acres) located in the central part of the planning area in lower Cook Inlet (Fig. II.H.1). The subarea removed by the deferral alternative consists of 117 whole and partial blocks (540,000 acres), about 29 percent of the proposed sale area. The blocks proposed for deferral lie entirely north of Anchor Point and comprise all the sale blocks north of Anchor Point. Deletion of the blocks north of Anchor Point was proposed by the United Cook Inlet Drift Association during testimony at the Anchorage Public Hearing. As noted in the description of the Coastal Fisheries Deferral Alternative (Sec. I.D.2.a(2)), the area north of Anchor Point is the heart of the Cook Inlet salmon gillnet fishery. Deferral of these blocks would eliminate fishing-gear conflict between commercial-fishing activities and oil and gas operations in the OCS area north of Anchor Point. Also, there would be no discharges from drilling and production operations in the area. The blocks proposed for deletion from the sale area by this deferral alternative include some of the blocks proposed for deletion in Alternatives IV, V, and VII (Figs. II.D.1, II.E.1, and II.G.1, respectively).

Resource Estimates and Basic Exploration, Development, and Production Transportation Assumptions for Effects Assessment: The resources for this alternative are assumed to be 140 MMbbl, approximately 30-percent less than Alternative I. Accordingly, resource-exploration and -development time frames for of oil activity also would be somewhat less than for the Proposal. As indicated in Table IV.A.1-1, Alternative VIII has 5 rather than 8 exploration-period wells, 2 rather than 3 production platforms, and 60 percent of the production and service wells (29). Most other exploration, production, and transportation assumptions, including developmental timeframes, life of field, and facility locations, as discussed in the base-case scenario of the proposed action, virtually will be the same for this alternative. Please see Table IV.A.1-1.

Probability of One or More Spills Greater than or Equal or 1,000 Barrels Occurring: For this deferral alternative, there is a 19- percent probability of one or more spills ≥1,000 bbl occurring as compared to 27 percent for Alterative I (base case) (Table IV.A.2-2). The probability of one or more spills ≥1,000 bbl from (1) platforms is 8 percent, (2) pipelines is 9 percent, and (3) tankers is 4 percent compared to 12, 13, and 6 percent, respectively, for Alternative I (base case) (Appendix B, Table B-1).

a. Effects on Water Quality:

For Alternative VIII, the activities associated with petroleum exploitation most likely to affect water quality in the CI/SS sale area are (1) the permitted discharges from exploration-drilling units and production platforms, (2) accidental oil spills, and (3) construction activities. Selecting the Northern Deferral Alternative would reduce the economically recoverable oil resources assumed for analysis from 200 MMbbl (Alternative I base case) to an assumed 140 MMbbl. The types of activities associated with exploiting the potential oil resources of this alternative are the same as for Alternative I (base case), but the levels of activities are reduced (Table II.A.1). The types and levels of activities include the number of wells drilled and quantities of muds and cuttings discharged, the number of production platforms and the types and quantities of discharges, the number of pipeline miles, and the number of oil spills and the amount spilled (Tables II.A.2-1, II.A.2-2, IV.A.2-2, and IV.A.2-4). The characteristics of the discharges, spills, and activities and their potential effects on water quality are described in Section IV.B.1.a and summarized in this section.

The benefits of this deferral alternative are derived from (1) a reduced level of drilling and production activities associated with the exploration for and production of an assumed 140 MMbbl of oil and (2) the exclusion of exploration-drilling units and production platforms from locating in the deferred areas—about 29 percent of the Sale 149 area; these areas are shown in Figure II.H.1. Compared to Alternative I (base case), the reduced level of drilling and production activities would result in a decrease in the amount of material discharged into the waters of Cook Inlet. Based on information from Table IV.B.1.a-2, the discharges would be reduced by about (1) 31 to 39 percent for the drilling muds, (2) 39 percent for the cuttings, and (3) 30 percent for the produced waters. Excluding the drilling units and production platforms from the deferred areas eliminates the direct release of the permitted discharges into the waters of these areas.

The hydrodynamic processes in the Cook Inlet Planning Area suggest the water column generally is well mixed, and dilution would reduce the concentration of the substances in the discharges. Degradation processes also act to continuously reduce the concentrations of many substances deliberately or accidentally released into the environment.

Of the permitted discharges, drilling muds and cuttings and produced waters are the most significant discharges associated with offshore operations. The permitted discharges would add substances that may be foreign to or increase the concentration of constituents already present in the water column of CI/SS. This analysis will consider (1) the chronic criterion (for the protection of marine life) for SPM/turbidity to range from 100 to 1,000 mg/l (Sec. IV.B.1.a(1)(a)1)), (2) 15 μg/l to be the chronic criterion (for the protection of marine life) and 1,500 μg/l—a hundredfold higher level—to be the acute criterion for total hydrocarbons (Sec. IV.B.1.a(1)(b)2)a)), and (3) 10 μg/l to be the chronic criterion (for the protection of marine life) and 1,000 μg/l to be the acute criterion for TAH (Sec. IV.B.1.a(1)(b)2)a)). In general, the added substances may cause sublethal effects in some marine organisms if concentrations are greater than the chronic criteria and lethal effects if concentrations are greater than the acute criteria.

Drilling of the 2 exploration, 3 delineation, and 29 production and service wells could result in the discharge of an estimated 4,120 to 12,530 tons (dry weight) of drilling-mud components and 18,440 tons (dry weight) of cuttings (Table IV.B.1.a-2). The concentrations of discharged drilling muds initially may range from about 1,000 to 2,000 g/l and are expected to be greater than the SPM turbidity chronic criteria, 100 to 1,000 mg/l, assumed for this analysis. However, within about 100 to 200 m of the discharge point, mixing in the water column would reduce the concentrations by a factor of 10,000 to 1,000,000; the diluted concentrations are estimated to range from 1 to 200 mg/l. The concentration of suspended particulate matter in lower Cook Inlet and Shelikof Strait ranges from about 1 to 50 mg/l. Most of the solids in the discharges settle rapidly to the seafloor, where bottom currents disperse the finer particles. The drilling discharges are expected to take place over a 5- or 6-year period—most of the discharges would occur in the last 3 years and be associated with the drilling of the production and service wells.

Produced waters constitute the largest source of substances discharged into the marine environment, and their discharge is an issue of significant concern because of the types and amounts of naturally occurring substances they may carry and the manmade substances that may be added. The amount of produced water that would be discharged as a consequence of producing an assumed 140 MMbbl of oil in 19 years is estimated to range from about 13 to 104 MMbbl, or more (Table IV.B.1.a-2). The toxicity of produced waters mainly is caused by hydrocarbons that include nonvolatile hydrocarbons (USEPA oil and grease) and aromatic hydrocarbons. The discharges associated with production activities are expected to last for the life of the field(s), at least 19 years, and the rates increase with time. The concentrations of nonvolatile hydrocarbons and TAH in the produced waters are estimated to range from 19 to 36 mg/l (19,000-36,000 μg/l) and 8 to 13 mg/l (8,000-13,000 μg/l), respectively.

The dilution rates for the produced waters are estimated to range from about 1,000:1 to 1,000,000 within several hundred meters of the discharge site. If dilutions are based on a rate of 1,000:1, the concentrations of nonvolatile hydrocarbons (oil and grease) within several hundred meters of the platform might range from 19 to 36 μg/l and the concentrations of TAH might range from 8 to 13 μg/l. These concentrations are well below the acute criteria of 1,500 μg/l for the nonvolatile hydrocarbons and 1,000 μg/l for the TAH that were assumed for this analysis but, in general, slightly greater than the chronic criteria of 15 μg/l for the nonvolatile hydrocarbons and 10 μg/l for the TAH. If dilutions rates are about 10,000:1, the concentrations of nonvolatile hydrocarbons might range from about 2 to about 4 μg/l and the concentrations of TAH might be about 1 μg/l; these concentrations are less than the respective chronic criteria assumed for analysis. When discharged, the toxicity of the produced waters is expected to range from slightly toxic to practically nontoxic and will decrease with continued mixing in the water column.

The characteristics of the other constituents of the produced waters or other production-related discharges are expected to be within the USEPA criteria and/or be diluted in the water column within an area <2 km^2 to background concentrations or levels that would not cause sublethal to lethal effects in marine organisms.

The potential effects in any of the areas where there are permitted discharges would last for about (1) 2 to 3 months for each exploration well drilled and (2) 22 years for development and production activities. Future procedures and technologies of treating and handling drilling muds and cuttings and produced waters may reduce or eliminate the amounts discharged.

Accidental oil spills introduce into the water column a variety of hydrocarbon compounds whose concentrations may cause sublethal to lethal effects in marine organisms. Hydrodynamic and meteorological forces increase the areal extent of the spill and physical, chemical, and microbiological forces degrade the oil and reduce its concentration and toxicity.

The number of small (<1,000-bbl) accidental oil spills that might occur if oil is produced is estimated to be 34; the total volume of oil spilled is estimated to be 325 bbl (33 spills that average 5 bbl in size and one 160-bbl spill) (Tables IV.A.2.4b and 4c). At the end of 3 days assuming no cleanup, the oil from a small spill may be dispersed in a 1- to km^2 area in concentrations of about 20 to 61 μg/l. The concentration of the dispersed oil 10 days after a spill is estimated to be between 3 and 14 μg/l in an area of about 9 to 48 km^2 and, after 30 days, <1 to about 1 μg/l in an area of 34 to 199 km^2. During the 3- to 30-day interval following a small spill, the concentration of oil in the water column is not expected to exceed the total hydrocarbon acute criterion, 1,500 μg/l, assumed for this analysis; however, the concentration of spilled oil is expected to exceed the assumed total hydrocarbon chronic criterion, 15 μg/l, for several days to weeks.

There is a 19-percent chance that one or more spills ≥1,000 bbl would occur, but if it did, the size of the spill is estimated to be about 50,000 bbl (Table IV.A.2-2). For a summer spill, the concentration of total hydrocarbons in the water column from a large spill is not expected to exceed the chronic criterion (1,500 μg/l), at least after 3 days, but may exceed the acute criterion (15 μg/l) for more than 30 days. In the summer at the end of 3 days assuming no cleanup, the oil from a large spill may be dispersed in a 190-km^2 area in concentrations of about 711 μg/l. The concentration of the dispersed oil 10 days after a spill is estimated to be about 163 μg/l in an area of about 912 km^2 and after 30 days, 21 μg/l in an area of about 3,715 km^2.

If the spill occurred in the winter, the size of the affected areas after the 3-, 10-, and 30-day-time intervals would be less than for a summer spill, but the concentration of oil in the water column would be greater. The oil in the water column is not expected to exceed the total hydrocarbon acute criterion (1,500 μg/l) during (1) the 3- to 30-day interval following a large spill under open-water conditions and (2) the 10- to 30-day interval after a large spill in broken ice. During the 3- to 10-day interval following a large spill, the oil in the water column is expected to exceed the total hydrocarbon acute criterion (1,500 μg/l) under broken-ice conditions. The concentration of total hydrocarbons in the water column during the winter may exceed the chronic criterion (15 μg/l) for >30 days.

Construction activities would increase the turbidity in the water column along segments of a 100-mi corridor for about 1.7 to 3.4 months, but there would be no overall degradation of the water quality.

<u>Summary</u>: The discharge of drilling muds and cuttings and other discharges associated with exploration drilling are not expected to have any effect on the overall quality of the Cook Inlet water. Within a distance of between 100 and 200 m from the discharge point, the turbidity caused by SPM in the discharged muds and cuttings is expected to be diluted to levels that are less than the chronic criteria (100-1,000 mg/l) and within the range associated with the variability of naturally occurring SPM concentrations. Mixing in the water column would reduce the toxicity of the drilling muds, which in general, are practically nontoxic, to levels that would not be harmful to organisms in the water column. In general, the amounts of additives in the other discharges are expected to be relatively small (from 1 to 100 or 200 g/month) and diluted with seawater several hundred to several thousand times before being discharged into the receiving waters.

The discharge of produced waters is not expected to degrade the quality of Cook Inlet water. Mixing and weathering processes continuously will reduce the concentrations of the hydrocarbons in the produced waters. Mixing is expected to reduce the concentrations of the nonvolatile hydrocarbons and TAH's to concentrations that are less than the chronic criteria of 15 μg/l and 10 μg/l, respectively. The pH of the produced waters is expected to be within the range specified by the USEPA. The salinities of the produced waters would be within the range of salinities that are found in Cook Inlet. The discharge of metals, as indicated by zinc, generally would be less than the amounts streams and rivers discharge into Cook Inlet. Mixing in the water column would reduce the toxicities of the produced waters, which in general, may range from slightly toxic to practically nontoxic prior to discharge.

Small oil spills, as represented in this analysis by 5- and 160-bbl spills, are not expected to have any degradational effects on the overall water quality of Cook Inlet. The small spills would degrade the water quality for a relatively short period of time, perhaps up to about 10 days, in areas of less than about 50 km^2. As noted in Section III.A.5.c(4)(e), the concentrations of any of the various types of hydrocarbons in the water column generally are quite low or below detection limits.

A large oil spill (≥1,000 bbl), as represented in this analysis by a spill of 50,000 bbl of crude oil, would degrade the quality of Cook Inlet water for a period of about a month or longer in an area that might extend over several thousand square kilometers; the probability of such a spill occurring is estimated to be 19 percent. If the spill occurs within a relatively short period of time, as measured in hours, the hydrocarbon concentration in the water column generally is expected to be less than the acute criterion (1,500 μg/l) within several days. However, the hydrocarbon concentration may remain greater than the chronic criterion (15 μg/l) for a month, or more.

Conclusion: The permitted, routine discharges associated with oil and gas development and small (<1,000-bbl) oil spills are not expected to cause any measurable overall degradation of Cook Inlet water quality; routine discharges would be prohibited in the deferred areas (about 29% of the Sale 149 area) and the amounts discharged reduced (about 30-40%). Water quality would be reduced from good (unpolluted) to polluted by the presence of hydrocarbons from one or more large (≥1,000-bbl) oil spills, which have a relatively low chance (19%) of occurring. Contamination (the presence of hydrocarbons in amounts >15 μg/l) would be temporary (last for a month, or more) and affect an area of several thousand square kilometers.

b. Effects on Lower Trophic-Level Organisms: Routine activities associated with the Northern Deferral Alternative (Alternative VIII) that may affect lower trophic-level organisms include seismic surveys, drilling discharges, and dredging or construction. Accidental activities include exposure to petroleum-based hydrocarbons from an oil spill. The effects of these routine and accidental activities on lower trophic-level organisms are discussed in the base case (Sec. IV.B.1.b) and are summarized below. The following analysis for Alternative VIII focuses on the differences in the amount of activity (the only variable) estimated for Alternative VIII, as compared to that of the base case. It then estimates the resulting effect of this difference on lower trophic-level organisms for Alternative VIII.

This alternative would delete 117 blocks, or about 29 percent of the sale area discussed in the base case. This eliminates any OCS activity in the deferral areas and would eliminate them as areas where a platform oil spill could originate. However, platforms outside the deferral areas would remain as a potential oil-spill source, and would be likely to affect the southern to mid portion of the deferral area. More importantly, the probability of one or more oil spills occurring from an oil tanker or pipeline (the primary oil-spill sources) for the deferral area is nearly the same as that of the base case. Hence, in terms of an oil spill, the essential difference between Alternative VIII and the base case is the extra time it would take for a platform (now outside of the deferral areas for Alternative VIII) spill to reach deferral-area shorelines. This extra time would reduce the amount of toxic hydrocarbons reaching deferral-area shorelines. However, the surface oil (the most damaging aspect of spilled oil) still would reach these shorelines. Further, because of the speed of water movement in Cook Inlet/Shelikof Strait, the reduction in toxicity that would occur while the oil was traversing the deferral areas may be relatively small, depending on where the spill originated. For these reasons, and because there only would be a minor change from the base case in the probability of an oil spill from the primary oil-spill contributors (tankers and pipelines), the effects of Alternative VIII on lower trophic-level organisms are expected to be essentially the same as discussed for the base case, and are summarized below.

Seismic surveys are expected to have little to no effect on lower trophic-level organisms. Drilling discharges are estimated to affect <1 percent of the benthic organisms in the sale area and none of its plankton. Recovery is expected to occur within 1 year. Dredging and construction are expected to have little or no effect on plankton communities. Less than 1 percent of the immobile benthic organisms would be affected. Immobile benthic communities affected by pipeline construction are expected to recover in <3 years. The effects of petroleum-based hydrocarbons on phytoplankton, zooplankton, and benthic organisms range from sublethal to lethal. Where flushing times are longer and water circulation is reduced (e.g., bays, estuaries, and mudflats), adverse effects are expected to be greater, and the recovery of the affected communities is expected to take longer. Large-scale effects on plankton due to petroleum-based hydrocarbons have not been reported. Assuming that a large number of phytoplankton were contacted by an oil spill, the rapid replacement of cells from adjacent waters and their rapid regeneration time (9-12 hours) would preclude any major effect on phytoplankton communities. Observations in oiled environments have shown that zooplankton communities experienced short-lived effects due to oil. Affected communities appear to rapidly recover from such effects because of their wide distribution, large numbers, rapid rate of regeneration, and high fecundity. Large-scale effects on marine plants and invertebrates due to petroleum-based hydrocarbons have not been reported. The sublethal effects of oil on marine plants include reduced growth and photosynthetic and reproductive activity. The sublethal effects of oil on marine invertebrates include adverse effects on reproduction, recruitment, physiology, growth, development, and behavior (feeding, mating, and habitat selection).

Based on the assumptions discussed in the text (see Sec. IV.B.1.b), the assumed oil spill for Alternative VIII is estimated to have sublethal and lethal effects on 1 to 5 percent of the phytoplankton and zooplankton populations in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. The total percentage of plankton affected could increase to 5 percent if many embayments were contacted by the spill. Recovery within the affected embayments is expected to take 1 to 2 weeks. Marine plants and invertebrates in subtidal areas are not likely to be contacted by an oil spill, but marine plants and invertebrates in intertidal and shallow subtidal areas are likely to be contacted by an oil spill. Based on the assumptions discussed in the text (see Sec. IV.B.1.b), the assumed oil spill for Alternative VIII is estimated to have lethal and sublethal effects on about 20 to 30 percent of the intertidal and shallow subtidal marine plants and invertebrates in the sale area. Recovery of these communities is expected to take 2 to 3 years in high-energy habitats and up to 7 years in lower energy habitats. Small oil spills (estimated total of 325 bbl) may adversely affect individual lower trophic-level organisms in small areas immediately around the spills (Table IV.A.2.4-d). However, they are not expected to have perceptible effects on lower trophic-level organisms at the population level.

Conclusion: Alternative VIII is expected to have essentially the same effect as that of the base case. The assumed oil spill associated with Alternative VIII is estimated to have lethal and sublethal effects on 1 to 5 percent of the plankton in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 2 weeks for zooplankton. It also is estimated to have lethal and sublethal effects on about 20 to 30 percent of the intertidal and shallow subtidal marine invertebrates in the sale area. Recovery of these communities is expected to take 2 to 3 years in high-energy habitats and up to 7 years in lower energy habitats. Less than 5 percent of the subtidal benthic populations in the sale area are expected to be affected. All of the above effects are based on the assumptions discussed in the text (i.e., the 50,000-bbl oil spill occurs, and land segments having a probability of contact ≥ 1 percent are contacted).

c. Effects on Fisheries Resources: The Northern Deferral Alternative (Alternative VIII) removes all lease blocks north of Anchor Point. This reduces the probability of a spill from platforms and reduces the amount of noise and disturbance in and around certain coastal fisheries resources. The effect of this deferral alternative will be examined using 30-day combined probabilities. Effects on fisheries from (1) oil spills and oil pollution, (2) noise and disturbance, and (3) habitat loss and/or alteration were analyzed in full under the base case (Sec. IV.B.1.c).

The effects of an oil spill were reviewed for fisheries resources in the sale area. Sale-specific oil-spill effects on fisheries resources were estimated using combined probabilities generated from the OSRA model. Effects on fisheries derived from the EVOS studies were used to estimate potentially lethal effects of an oil spill on fisheries resources. Sale-specific oil-spill effects are not expected to directly affect returning adult salmon or steelhead. Oiled intertidal areas could cause an increased mortality to pink salmon eggs in the affected areas, but the increased egg mortality is not expected to cause reduced adult survival. An increased level of developmental malformations and increased egg-larval mortality could cause reduced survival to adulthood in herring populations affected by an oil spill. These effects are expected to be limited to the year-class spawned during the spill year and be masked to some extent by the contribution of other year-classes to the herring population. Eggs and larvae of some semidemersal and demersal fishes may suffer increased mortality from oil contact. Also, some demersal fish populations could be exposed to oil in the event of a spill, and a few individuals could be killed. But based on experience of the EVOS, it is unlikely there would be any population-level effects to demersal fishes.

Indirect effects such as ingesting oil from contaminated food could cause slower growth of pink salmon juveniles due to the metabolic cost of depurating the hydrocarbon burden. This may cause an incremental reduction in survival to adulthood but is not expected to have population-level effects.

Fisheries resources could be disturbed and displaced from the immediate vicinity of drilling discharges, within a radius probably not to exceed 100 m. These effects on demersal fishes very likely would be limited to only the short time periods of the discharge. Offshore construction also could temporarily disturb and/or displace fisheries resources. Any disturbance or displacement should be short term (hours to days), limited to only the time of construction and shortly thereafter. Though seismic surveys may damage eggs and larvae of some fishes, this injury is limited to within a meter or two from the airgun-discharge ports. Thus, seismic surveys probably would have no appreciable adverse effects on fish populations.

The OSRA model estimates a 3-, 7-, and 3-percent chance of one or more spills ≥1,000 bbl occurring and contacting ERA's 1, 4, and 5 (Tuxedni Bay, outer Kamishak Bay, or inner Kamishak Bay), respectively, within 30 days over the production life of the proposed action (≤5% is considered low; areas with a ≤5% chance of occurrence and contact are not discussed). The chance of spill contact from production is reduced only slightly in Tuxedni Bay (ERA 1) and inner and outer Kamishak Bay (ERA's 5 and 4). This alternative only slightly reduces risk to outmigrating salmonid smolts along western Cook Inlet in the vicinity of Tuxedni Bay to Chinitna Bay and eastern Cook Inlet from the Kenai River south to the Anchor River.

In summary, the estimated spill effects under the northern deferral would be unchanged from the base case. Adult salmon and steelhead should not be affected. Oiled intertidal areas have the potential for increased mortality to pink salmon eggs, and some juvenile pink salmon could have slower growth rates due to ingestion of oil-contaminated food. There could be an increased level of developmental malformations and increased egg-larval mortality in herring. Eggs and larvae of some demersal and semidemersal fish also could suffer some increased mortality. The short-term, local effects of noise disturbance and habitat alteration would be lessened for the fisheries resources in the deferral area.

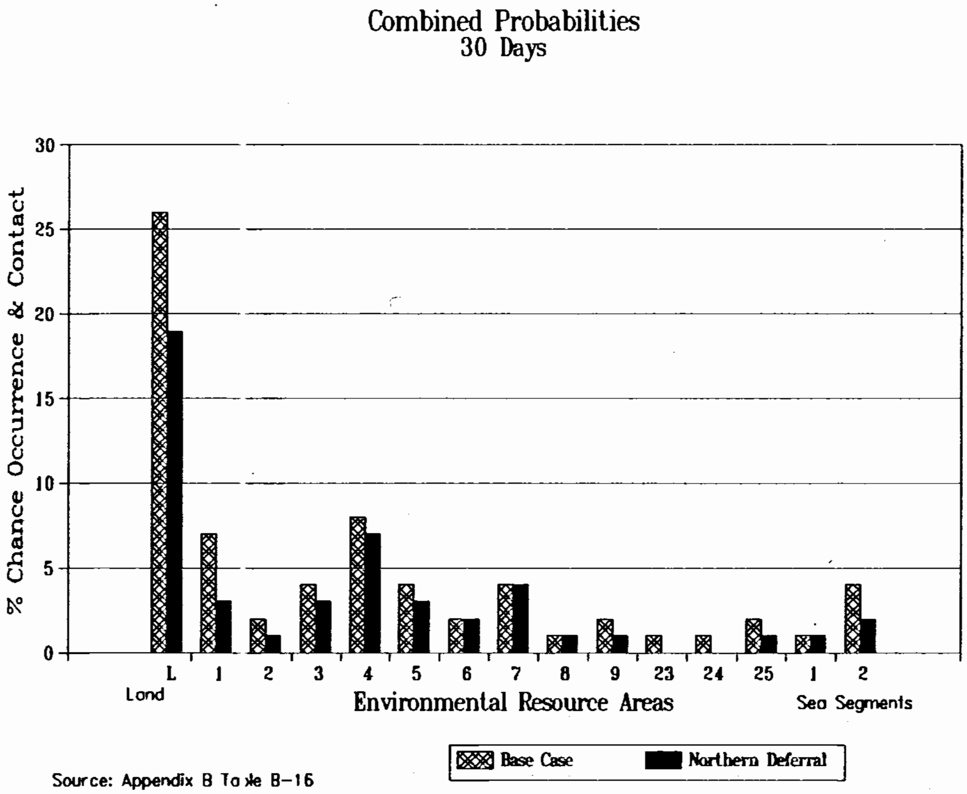
Conclusion: Compared to the base case, the estimated spill effects would be unchanged (with the potential for increased mortality in pink salmon eggs and an increased level of developmental malformations and increased egg-larval mortality in herring). Eggs and larvae of some demersal and semidemersal fish also could suffer some increased mortality. Potential noise and disturbance effects to these fishery resources due to exploration and production in these areas also would be eliminated. The various effects to fisheries resources taken altogether are not expected to cause population-level changes.

d. Effects on Marine and Coastal Birds: The Northern Deferral Alternative would remove approximately 117 whole and partial blocks (about 29% of the sale area) from the proposed lease sale, leasing only those blocks in the central southern part of the Cook Inlet Planning Area. This alternative would avoid potential platform-spill-contact risks to the Tuxedni Bay area (including Chisik and Duck Islands) and lower Cook Inlet, important habitats of marine and coastal birds. The chance of one or more oil spills ≥1,000 bbl occurring decreases from 27 percent in the base case to 19 percent in this alternative.

Leasing would be deferred (1) from an area near the seabird colonies on Chisik and Duck Islands, (2) from waterfowl and shorebird habitats in Tuxedni and Chinitna Bays, and (3) from other important habitat areas along the coast of the Kenai Peninsula north of Anchor Point (see Fig. II.H.I).

A comparison of Alternative I and Alternative VIII combined probabilities (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting environmental resource areas important to marine and coastal birds is shown in Figure IV.B.8.d-1. Alternative VIII reduces the combined probabilities to 12 of the 15 environmental resource areas (including land in general) estimated under Alternative I. The highest reductions in chance of one or more ≥1,000-bbl-oil spills occurring and contacting are to land in general (reduced from 26-19%) and Tuxedni Bay (ERA 1, reduced from 7-3%). There is a slight reduction (1%) in spill occurrence and contact to Chinitna Bay, Kachemak Bay, inner and outer Kamishak Bay, the Katmai area, and Portlock Bank (Fig. IV.B.8.d-1, ERA's 2, 3, 4, 5, 9, and 25, respectively). These reductions in combined probabilities to environmental resource areas generally reflect the reduction in volume of oil assumed present in the alternative compared to the base case after the oil in the deferred tracts is subtracted.

Thus, some limited or slight reduction of oil-spill risks on seabirds, sea ducks, and shorebirds and their habitats in Tuxedni, Chinitna, Kachemak, and Kamishak Bays, the Katmai area, and Portlock Bank is expected to occur under this alternative. However, the probabilities of occurrence and contact to these and other coastal habitats of marine and coastal birds in lower Cook Inlet and the Gulf of Alaska still are high enough to expect that the assumed 50,000-bbl oil spill would occur and contact at least one or more of the environmental resource areas—important habitats of marine and coastal birds; there still is a 19-percent chance of one or more ≥1,000-bbl spills occurring and contacting land-shoreline and affecting several thousand to perhaps 100,000 birds (Fig. IV.B.8.d-1). If a tanker spill occurred in the Kennedy Entrance to Cook Inlet or in the Gulf of Alaska, the Barren Islands' seabird-colony-concentration area is estimated to be contacted by the spill, and several thousand to perhaps more than 100,000 seabirds are expected to be lost (Fig. IV.B.1.d-3:T-4 and ERA 6). Thus, the potential oil-spill effects to the seabird colonies and to other marine and coastal birds and their habitats in lower Cook Inlet are expected to remain about the same as for the Proposal.



Source: Appendix B Table B-16

Figure IV.B.8.d-1. Combined Probabilities (expressed as percent chance) of One or More Spills ≥1,000 Barrels Occurring and Contacting Certain Environmental Resource Areas Within 30 Days Under the Base Case and Under Alternative VIII Over the Assumed Production Life of Sale 149 Area.

Noise and disturbance and habitat-alteration effects on marine and coastal birds are expected to be the same as described under the Alternative I base case, because the transportation scenario and levels of exploration and development activities for this alternative are expected to be the same as for the Proposal.

Conclusion: The overall effect of Alternative VIII on marine and coastal birds (the loss of several thousand to perhaps 100,000 birds, with recovery taking >1 generation [perhaps 3 generations or 15 years]) is expected to be about the same as described under the base case. Oil-spill effects on bird populations potentially could be slightly reduced locally in the Tuxedni, Chinitna, Kachemak, and Kamishak Bays, and in the Katmai area and the Portlock Bank habitat.

e. Effects on Nonendangered Marine Mammals (Pinnipeds, Cetaceans, and the Sea Otter): The Northern Deferral Alternative (Alternative VIII) removes all lease blocks north of Anchor Point. This reduces the probability of a spill from pipelines or platforms and reduces the amount of noise and disturbance in and around certain coastal fisheries resources and wildlife areas. The effect of this deferral alternative will be examined using 30-day combined probabilities on the most sensitive marine mammal resource areas in the sale area that could be affected under the base case. Effects on marine mammals from (1) oil spills and oil pollution, (2) noise and disturbance, and (3) habitat loss and/or alteration were analyzed in full under the base case (Sec. IV.B.1.e).

Sale-specific oil-spill effects on marine mammal resources have been estimated using combined probabilities generated from the OSRA model Mortality rates derived from the EVOS and adjusted by the SF were used to estimate potentially lethal effects of an oil spill on each species. Sale-specific oil-spill effects were estimated to result in the mortality of <10 fur seals and killer whales, respectively; approximately 43 beluga whales; approximately 60 harbor seals; and between 75 to 100 sea otters. Recovery to prespill numbers was estimated to occur in about 1 to 2 years except for beluga whales, where recovery could require as much as 7 years.

Effects to marine mammals from noise and disturbance also were reviewed and estimated. The loudest noise source created by industry activity was identified as seismic noise. Sounds generated by seismic surveys probably would not affect harbor and fur seals and sea otter activities. Effects on the minke whale have not been studied but likely would be similar to effects on other baleen whales, which generally are tolerant of seismic pulses. Subtle behavioral changes may occur on occasion at low-sound levels, with stronger avoidance reactions when sound levels reach 160 to 170 dB, or higher. Toothed-whale hearing appears poor at frequencies lower than 1 kHz, where most industrial sounds and seismic pulses are produced, so they probably would be unaffected.

Aircraft overflights can be another potential source of disturbance. Pinniped response to low-altitude aircraft can result in stampede or flight into the water. This may increase pup mortality during the pupping season. Both baleen and toothed whales usually respond to low overflights by diving. Reactions of pinnipeds and cetaceans vary by aircraft type, altitude of flight, and circumstances of the animals. These disturbance reactions usually are short term, with seals reoccupying haulouts and whales continuing their activities usually within a matter of hours.

The effects of habitat alteration/degradation also were examined. These would be limited to temporary disturbance to some sea otters and harbor seals in the nearshore environment associated with construction of pipeline and transport facilities. This disturbance likely would be relatively short term and very localized and should not affect survival.

The OSRA model estimates a 3-, 7-, and 3-percent chance of one or more spills ≥1,000 bbl occurring and contacting ERA's 1, 4, and 5 (Tuxedni Bay, outer Kamishak Bay, or inner Kamishak Bay), respectively, within 30 days over the production life of the proposed action (≤5% is considered low; areas with a ≤5% chance of occurrence and contact are not discussed). The chance of spill contact from production is reduced only slightly in Tuxedni Bay (ERA 1) and inner and outer Kamishak Bays (ERA's 5 and 4). Other areas in lower Cook Inlet with slightly reduced risk because of the deferral are Chinitna Bay (ERA 2) and Kachemak Bay (ERA 3). This alternative slightly reduces risk to sea otters, harbor seals, and beluga whales in Kamishak Bay; harbor seals and beluga whales in Tuxedni Bay; and sea otters, harbor seals, fur seals, and nonendangered cetaceans in Chinitna Bay and Kachemak Bay.

In summary, the estimated spill effects under the northern deferral would be unchanged from the base case with a potential mortality of <10 fur seals and killer whales, respectively; approximately 43 beluga whales;

approximately 60 harbor seals; and between 75 to 100 sea otters. Recovery to prespill numbers is estimated to occur in about 1 to 2 years, with the exception of beluga whales, where recovery may require up to 7 years. The short-term, local effects of noise, disturbance, and habitat alteration would be lessened for the nearshore species in the deferral area. These include sea otters, harbor seals, foraging fur seals, and some nonendangered cetaceans.

Conclusion: Compared to the base case, the estimated oil-spill effects under this deferral alternative would be unchanged, with a potential mortality of < 10 fur seals and killer whales, respectively; approximately 43 beluga whales; approximately 60 harbor seals; and between 75 to 100 sea otters. Recovery to prespill numbers is estimated to occur in about 1 to 2 years, with the exception of beluga whales, where recovery could require up to 7 years. Potential noise and disturbance effects to these marine mammals due to exploration and production in these areas also would be eliminated by the deferral alternative.

f. Effects on Endangered and Threatened Species: Alternative VIII (Northern Deferral) would remove lease blocks from the proposed sale area north of the latitude of Anchor Point. This area is well outside the zone of probable seasonal occurrence of endangered whale species and areas potentially used by higher densities of foraging or rafting Steller sea lions from the major Barren Islands rookery. Nevertheless, this alternative removes approximately 29 percent of the area within which, under Alternative I (proposed action, Sec. IV.B.1.f), an extremely small proportion of the sea lion population potentially could be exposed to routine exploration and development/production activities.

For this population, the most likely sources of potentially adverse effects associated with routine activities are disturbance (primarily aircraft and vessel traffic) and release of drilling muds and cuttings. However, as discussed for Alternative I, potential effects from routine activities already are likely to be minimal because of the expectation that travel routes of few whales or sea lions will intersect those of vessels or aircraft, or approach a platform, and that any interaction effects (e.g., travel direction change, area avoidance) will last for less than an hour. Likewise, exposure of whales or sea lions, or their prey species, to any materials released into the environment (e.g., muds and cuttings) is expected to have minimal effects due to rapid dispersal of such materials to nontoxic concentrations in this oceanographically dynamic area.

Only a minor decrease in risk to whales and sea lions from Alternative I is expected because of the extremely low densities of these species likely to occur in the northern portion of the sale area and because the probability of one or more spills decreases by less than 10 percent (from 27%-19%, Table IV.A.2-2). South of the proposed sale area, the potential for occurrence and contact of one or more ≥1,000-bbl spills to Puale Bay, for example (ERA 12), where effects on contacted sea lions would be as described under Alternative I (losses requiring at least 1 generation for recovery), remains essentially unchanged (<0.5%, Table B-16); in northern Shelikof Strait areas (ERA's 7-11), the chance of contact declines slightly (0-1%, to values ranging from <0.5-4%) from Alternative I with this deferral. The combined probability (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting areas occupied by wintering Steller's eiders (ERA's 3, 5, 7-12) declines from ≤4 percent (Kachemak Bay) to ≤3 percent.

Potential effects from this alternative are expected to be reduced to an extremely limited extent from those discussed for Alternative I, which include: (1) Exposure of ≤1 percent of the North Pacific fin whale and 5 percent of humpback whale populations occurring in this area to disturbance, with individuals being affected for an hour or less per incident. (2) Similarly small numbers of whales exposed to an oil spill, with any effects sublethal and short term. (3) A tanker spill outside entrances to Cook Inlet/Shelikof Strait contacting larger numbers of whales east of Kodiak Island, but without the occurrence of any mortality. (4) Less than 2 percent of the central Gulf of Alaska Steller sea lion population (5% of the potentially affected area population) exposed to potentially disturbing activities, with no rookeries or haulouts likely to be disturbed. (5) An oil spill potentially contacting up to several hundred sea lions, but adult mortality not exceeding a few tens of individuals (pups and juveniles expected to be more severely affected). (6) Overall sea lion mortality resulting from an oil spill is expected to be less than 100 individuals, requiring a recovery period of at least one generation. (7) No endangered or threatened bird populations affected by exploration or development/production activities. (8) Wintering Steller's eiders unaffected by exploration activities but potentially experiencing oil-spill losses requiring two generations for recovery.

In summary, this alternative is expected to provide limited local reduction in disturbance and a slight reduction in potential oil-spill effects by reducing the probability of oil spills in areas that may be seasonally occupied by small numbers of endangered whales, low densities of Steller sea lions, and Steller's eiders wintering along the Alaska Peninsula to Kodiak Island and Kachemak Bay.

Conclusion: The overall effect of this alternative is expected to be essentially the same as determined for proposed Alternative I (effects on whales nonlethal, sea lions requiring at least 1 generation for recovery, Steller's eider requiring 2 generations for recovery), because the major sources of an oil spill remain unchanged and effects of disturbance already are minimal

g. Effects on Terrestrial Mammals: This alternative would provide potential platform oil-spill protection for coastal habitats of brown bears, river otters, and other terrestrial mammals along the coast of the Alaska Peninsula from Chinitna Bay north and along the coast of the Kenai Peninsula north of Anchor Point (Fig. II.H.1). The estimated chance of one or more oil spills ≥1,000 bbl occurring decreases from 27 percent under the base case to 19 percent under Alternative VIII.

A comparison of Alternative I and Alternative VIII combined probabilities (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting land segments representing coastal (shoreline) habitats of terrestrial mammals is shown in Figure IV.B.8.g-1. Alternative VIII reduces the combined probabilities of spill occurrence and contact to 10 of the 19 land segments estimated under Alternative I. A slight reduction (1%) in the probability of one or more ≥1,000-bbl spills occurring and contacting is shown for the following areas: Cape Douglas (LS 22), Iniskin Bay north to Tuxedni Bay on the Alaska Peninsula (LS's 29-32), Kalgin Island (LS 35), and the Kenai area, Ninilchik area, and Kachemak Bay on the Kenai Peninsula (LS's 40, 42, and 44, respectively) and the western Barren Islands (LS 47). These reductions in the probability of one or more ≥1,000-bbl spills occurring and contacting terrestrial mammal habitats reflect some local protection provided by the deferred tracts under this alternative as well as the reduced volume of oil (reflected by the lower chance of spill occurrence) expected under this alternative compared to the base case.

This alternative also eliminates potential platform-spill sites that have a >50-percent estimated conditional probability (expressed as percent chance) of contacting Tuxedni Bay (LS 32), an important brown bear area, and it eliminates potential platform-spill sites that have a >5-percent estimated conditional probability of contacting habitats north of the Anchor Point area (Appendix B, Figs. B-25 through B-29) within 30 days during the summer.

Although the above reductions in combined probabilities of spill occurrence and contact and the reduction in platform oil-spill-estimated contact probabilities provide some protection to terrestrial mammal habitats along the coast of lower Cook Inlet, the conditional probabilities of contact remain the same for a potential pipeline or tanker spill contacting these same coastal habitats. Thus, some local reduction of potential platform-oil-spill effects on brown bears, river otters, and other terrestrial mammals and their habitats along the coast of the Alaska Peninsula at Iniskin, Chinitna, and Tuxedni Bays and on the Kenai Peninsula is expected under this alternative. However, conditional oil-spill risks and effects from the assumed tanker route in and out of Cook Inlet and oil-spill risks from the pipeline route are expected to remain unchanged. Thus, the potential overall oil-spill effects on terrestrial mammals are expected to remain the same as described under the proposal (loss of <50 river otters, perhaps 100 deer, and 10 bears).

Noise and disturbance and habitat-alteration effects on terrestrial mammals are expected to be the same as described under the Alternative I base case (short-term and local displacement of small numbers of bears and other terrestrial mammals along aircraft routes associated with the alternative), with the same level of air and vessel traffic and the same onshore facilities to be constructed under both alternatives.

Conclusion: The overall effect of oil spills, noise and disturbance, and habitat alteration on terrestrial mammals is expected to be about the same as described under the base case (loss of <50 river otters, perhaps 100 deer, and 10 bears). Oil-spill effects on brown bears, river otters, and other terrestrial mammals are expected to be slightly reduced locally along the coasts of Iniskin, Chinitna, and Tuxedni Bays and on the Kenai Peninsula.

h. Effects on the Economy: Increased employment is the most significant economic effect generated by Alternative VIII, Northern Deferral. Employees would work on the construction, operation, and servicing of facilities associated with the sale. These facilities are described in the estimated and assumed scenario, Table IV.A.1-1, and are outlined as follows: 2 exploration wells; 3 delineation wells; 2 production platforms; 29 production/service oil wells; 1 shore base constructed; and 125 mi of offshore pipeline.

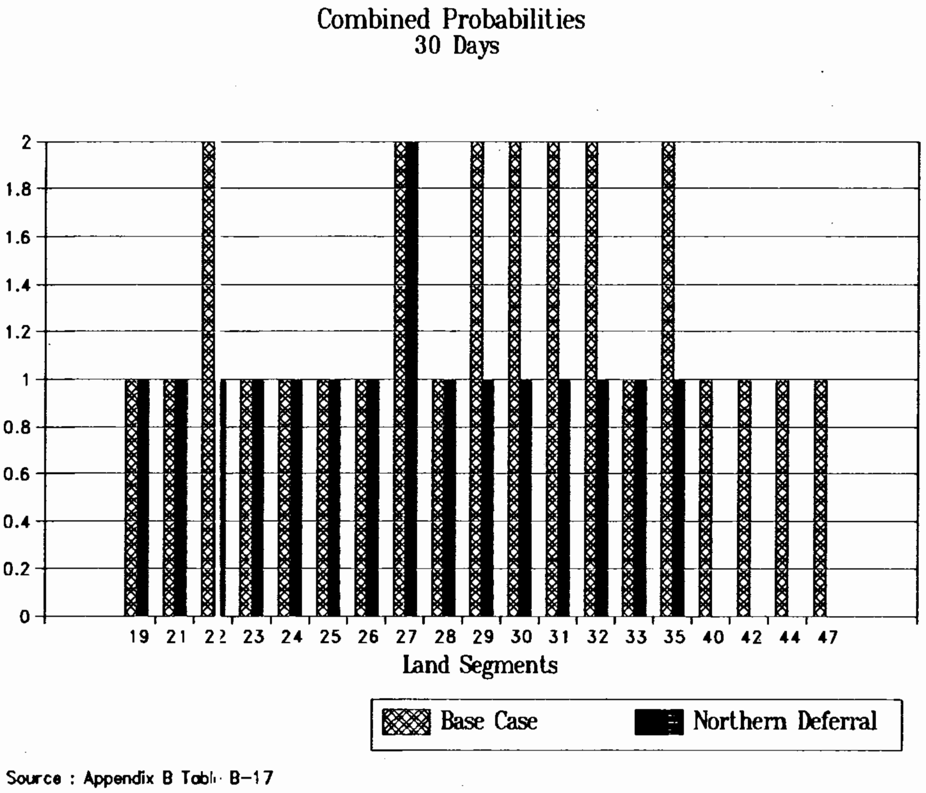


Figure IV.B.8.g-1. Combined Probabilities (expressed as percent chance) of One or More Spills ≥1,000 Barrels Occurring and Contacting Certain Land Segments Within 30 Days Under the Base case and Under Alternative VIII Over the Production Life of the Sale 149 Area.

For Alternative VIII, direct OCS resident employment on the western side of the Kenai Peninsula would start with 179 in 1997; rise to 245 in 1998 to 694 in 1999 and 1,054 in 2000; drop to 425 in 2001; rise to 1,080 in the year 2002; and drop to 398 in 2003. The employment level varies between 398 and 412 from year 2004 through 2020. Indirect resident employment is estimated to be 12.6 percent of direct OCS resident employment and would peak at 133 for the year 2000. (See Appendix G for a complete description of methodology for employment and population forecasts. Also see Section IV.B.1.h, Economy, for assumptions and general analytic methods used for this alternative.)

Resident employment on the western side of the Kenai Peninsula is estimated to be 15,986 for 1995 and is projected to rise 0.9 percent annually without the sale. Between the years 1997 and 2003, annual increases and decreases in OCS direct and indirect employment would be between 1 and 4 percent of total employment on the western Kenai Peninsula.

The OCS activity could generate effects on other facets of the economy including income, prices, and taxes. The OCS workers are likely to earn relatively high wages compared to the average income on the western part of the Kenai Peninsula. Even assuming that the income of the OCS workers was twice as high as the average for the western Kenai Peninsula, the effect on the average income would be to change it by <3 percent for <5 years. The reason for this is that the largest rise for 1 year in direct OCS employment is 655 workers in 2002 compared to resident employment of 16,869 in 2001.

Because of the relatively short period of time—6 years for the exploration and development phases—that housing would be needed for the large number of OCS workers, it is assumed that temporary housing would be provided by OCS lessees for over half of the OCS workers in these peak years. In the single peak years 2000 and 2002, temporary housing would be provided for about 400 OCS workers.

Revenue from property tax would increase <2 percent for <5 years for the Kenai Peninsula Borough (KPB). The value of taxable improvements to property during a peak year is estimated to be $40 million (1993 dollars), which is 1.3 percent of the total taxable valuation for the KPB in 1993 (Barnes, 1993, personal comm.). Primary components of taxable improvements are as follows: improvements in existing facilities equivalent to a new shore base and new housing for workers. It is assumed that 200 permanent housing units would be built for each of the 4 years following exploration, 1999 to 2002. At an average value of $100,000 (1993 dollars) per housing unit, the average value of new housing per year would be $10 million (1993 dollars). The value of improvements to shore-base facilities is estimated to be $30 million (1993 dollars) for the peak year.

Annual property-tax revenue of $1.7 million (1993 dollars) would accrue to the KPB and $0.4 million (1993 dollars) to the State after all major improvements are constructed or installed, which would be 2002. The improvements are estimated to be $100 million for shore-base improvements and $40 million for 400 new housing units. This total of $140 million of improvements at the rate of 12 mills results in property-tax revenue of $1.7 million. The mill rate of 12 is the approximate average of the mill rates for seven tax-code areas between Anchor Point and Nikiski; the mill rate accruing to the State of Alaska for oil facilities in this case is 8 (Alt, 1993, personal comm.). It is assumed that half of the shore-base improvements and all of the pipelines are oil facilities.

If the KPB had a sales tax during the period of OCS activity, the expenditures by direct OCS workers and indirect workers would translate to a maximum sales-tax revenue change of <4 percent for <5 years. This is because the sales-tax revenue would be in proportion to the increase in total income for all additional OCS workers in 1 year; and it is assumed that the income for OCS workers would be two times that of the average worker for the western Kenai Peninsula.

Headquarters employment is assumed to be located in Anchorage. It would rise from 10 in 1995 to 100 in 2003 to 200 from 2004 through 2012 and drop to 180 from 2013 through 2021. It would result in changes that are <1 percent of Anchorage employment in any given year.

The economic effects of oil spills <1,000 bbl would be very minimal. These small spills would be cleaned up by the CISPRI organization or some similar organization. A spill <1,000 bbl would require <50 person hours to clean up.

The most relevant historical experience in Alaskan waters to a tanker spill of 109,000 bbl (average tanker-size spill, see Sec. IV.A.2.a(4)) is the EVOS of 1989, which spilled 240,000 bbl. This spill generated enormous employment that rose to the level of 10,000 workers directly doing cleanup work in relatively remote locations. Smaller and smaller numbers of cleanup workers returned in the warmer months each year following 1989 until 1992. Numerous local residents quit their jobs to work on the cleanup at often significantly higher wages. This generated a sudden and significant inflation in the local economy (Cohen, 1993). Anecdotal information indicates that housing rents in Valdez in 1989 increased from 25 percent in some cases to sixfold in others, and inflated rents continued into 1990. Prices of food and other goods increased only slightly, because people could drive to Anchorage to purchase them (Henning, 1993, personal comm.). Research shows that no data on inflation were gathered in a systematic way during the EVOS, although most observers agree that there was temporary inflation.

The number of cleanup workers actually used for a spill associated with Sale 149 would depend to a great extent on what procedures are called for in the oil-spill-contingency plan, how well prepared with equipment and training the entities responsible for cleanup are, how efficiently the cleanup is executed, and how well in reality the coordination of cleanup is executed among numerous responsible entities. A spill resulting from activity associated with Sale 149 could generate half the workers associated with the EVOS, or 5,000 cleanup workers. The probability of a ≥1,000-bbl-oil spill occurring and contacting land would be 19 percent. Housing rents in the western Kenai Peninsula probably would double for 1 year following a major spill.

<u>Conclusion</u>: Alternative VIII, Northern Deferral, would generate changes slightly less than the base case. These changes would be between 1 and 4 percent in resident employment, <3 percent in average income, <3 percent in cost of living, <2 percent in property tax, and <4 percent in sales taxes on the western side of the Kenai Peninsula annually for <5 years. Property-tax revenue of $1.7 million for the KPB and $0.4 million for the State (in 1993 dollars) would be added annually after the year 2002.

A large oil spill, with a 19-percent probability of occurring and contacting land, would generate 5,000 cleanup jobs for 6 months in the first year, declining to zero by the fourth year following the spill. Local communities would experience a doubling of housing rents for 1 year.

i. Effects on Commercial Fisheries: Activities associated with the Northern Deferral Alternative (Alternative VIII) that may affect the Cook Inlet and Kodiak commercial-fishing industries include drilling discharges, offshore construction, seismic surveys, and oil spills. The effects of these activities are discussed in the base case (Sec. IV.B.1.i) and are summarized below. The following analysis for Alternative VIII focuses on the differences in the amount of activity (the only variable) estimated for Alternative VIII, as compared to that of the base case. It then estimates the resulting effect of this difference on the Cook Inlet and Kodiak commercial-fishing industries for Alternative VIII.

This alternative would delete 117 blocks, or about 29 percent of the sale area discussed in the base case. This eliminates any OCS activity in the deferral areas and would eliminate them as areas where a platform oil spill could originate. The probability of a platform spill occurring is estimated to be 8 percent compared to 12 percent for the base case. However, platforms outside the deferral areas would remain as a potential oil-spill source, and would be likely to affect the southern to mid portion of the deferral area. Also, the probability of one or more oil spills occurring from a tanker or pipeline for the deferral areas would be only slightly less (2% and 4%, respectively) than the base case. Hence, in terms of an oil spill, the primary difference between this alternative and the base case is the extra time it would take for a platform (now outside of the deferral areas for Alternative VIII) spill to reach the southern to mid portion of the deferral area. While this extra time likely would reduce the toxicity of the oil entering the deferral area, it would not be likely to reduce economic losses to the commercial-fishing industry due to closures. For these reasons, the effects of oil spills associated with Alternative VIII on the commercial-fishing industry are expected to be nearly the same as discussed for the base case; they are summarized below.

Drilling discharges associated with Alternative VIII are not expected to have an effect on commercial fishing due to the limited area affected near the platform-discharge point. Offshore construction, platforms, and pipelines are expected to result in some space-use conflicts (e.g., competition for docking space or gear loss); however, if the area north of Anchor Point is deferred, space-use conflicts are expected to be less than for Alternative I (base case). Seismic surveys, planned and coordinated with the commercial-fishing industry, are expected to have a minimal effect on the commercial-fishing industry. Due to the relatively small amount of oil involved (325 bbl), the 34 small oil spills (Table IV.A.2-4d) assumed for Alternative VIII are not expected to result in closures or reduced market values over the life of the proposal. Hence, they are not expected to have a measurable economic effect on the commercial-fishing industry. However, the assumed large (50,000-bbl) base-case oil spill is expected to affect pot, longline, trawl, drift-gillnet, and set-gillnet fisheries in Cook Inlet and Kodiak.

The estimated economic effect of the base-case oil spill on the Cook Inlet and Kodiak commercial-fishing industries is based on what occurred during the EVOS and GBOS, and primarily depends on the highly variable EVOS cost estimates (ranging from $9-43 million/year for 2 years). From 1983 to 1993, the value of the Cook Inlet commercial fishery appears to have ranged between about $50 and $135 million/year. Based on the above, in any 2-year period when the value of the Cook Inlet commercial fishery is estimated to be about $50 million/year, a 2-year loss of about $9 million/year represents an 18-percent/year loss for 2 years; whereas a 2-year loss of about $43 million/year represents an 86-percent/year loss for 2 years. In a 2-year period when the value of the Cook Inlet commercial fishery is estimated to be closer to $135 million/year, a 2-year loss of about $9 million/year represents a 7-percent/year loss for 2 years; whereas a 2-year loss of $43 million/year represents a 32-percent/year loss for 2 years. Because the occurrence of a large oil spill would preclude any knowledge of what the commercial fishery would have been worth, the value of the commercial fishery at the time of the assumed 50,000-bbl-oil spill is assumed to be the average annual value (1983-1993) of the Cook Inlet commercial fishery. Thus, in terms of the average annual value of the Cook Inlet commercial fishery (about $65 million), the assumed base-case oil spill is estimated to result in an economic loss of about 15 to 65 percent/year for 2 years. Estimated losses to the Kodiak commercial-fishing industry are expected to be less than half of that estimated for Cook Inlet, or about 5 to 25 percent/year for 2 years following the assumed 50,000-bbl Cook Inlet oil spill. This amounts to an estimated loss of about $4 to $19 million/year to the Kodiak commercial-fishing industry. However, the EVOS experience has demonstrated that compensation to the commercial-fishing industry for participating in the cleanup of a large Cook Inlet oil spill is likely to exceed these economic losses by several orders of magnitude.

<u>Conclusion</u>: Based on the assumptions discussed in the text (i.e., a 50,000-bbl spill occurs during the commercial-fishing season), EVOS-loss estimates, and the average annual value of the Cook Inlet and Kodiak commercial fisheries, the Northern Deferral Alternative is estimated to result in economic losses to the Cook Inlet commercial-fishing industry ranging from about 15 to 65 percent/year for 2 years following the assumed 50,000-bbl-oil spill. Losses to the Kodiak commercial-fishing industry from the same spill are estimated to range from about 5 to 25 percent/year for 2 years following the spill. The chance of one or more oil spills ≥1,000 bbl is estimated to be 19 percent.

j. Effects on Subsistence-Harvest Patterns: The effects-producing factors for Alternative VIII, the Northern Deferral Alternative, are the same as for the base case, including routine operations such as seismic surveys, the disposal of drilling muds and cuttings, and the operation of support facilities, as well as accidental events such as oil spills.

Geographically, Alternative VIII defers all blocks north of Anchor Point. Deferral of these blocks could reduce effects on coastal commercial fisheries and reduce the potential for effects on subsistence harvests in southern Kenai Peninsula communities as well as Nanwalek and Port Graham, although potential effects on these communities would be attributable moreso to facility operations and transportation considerations than proximity to leased blocks. Therefore, effects on subsistence-harvest patterns in these communities should be little changed from the base case by means of this alternative.

Besides geographic considerations, Alternative VIII differs from the base case in the reduction of exploration and delineation wells drilled (from 8-5), reduction in the number of production platforms used (from 3-2), reduction in the number of production wells drilled (from 48-29), and reduction in the amount of oil production (from 200-140 MMbbl). Reduced effects on subsistence resources could occur from reducing the number of exploratory and production wells drilled through factors such as the discharge of reduced amounts of drilling muds and cuttings and reduced numbers of helicopter and vessel trips in comparison with the base case, although such reductions may not produce measurable effects reductions. Otherwise, the number and location of pipeline landfalls; the number and location of shore bases; and the number of exploration, delineation, and production rigs in operation per year are the same as the base case. Effects on subsistence-harvest patterns from operating these facilities would be the same as in the base case.

Effects on subsistence-harvest patterns from oil-spill events essentially would be the same as the base case in that the production and transportation scenarios are the same as the base case. There is a 7-percent reduction (19% vs.

27% in the base case) in the chance of one or more oil spills ≥1,000 bbl occurring and contacting land within 30 days, and most of the contacts with land segments occur on the west side of Cook Inlet, relatively removed from subsistence-harvest areas. Reductions in the chance of one or more oil spills ≥1,000 bbl occurring and contacting specific land segments (used as surrogates for subsistence-harvest areas) within 30 days are marginal at best, with all reductions from the base case from 1 percent to <0.5 percent.

As a consequence of the above effects on subsistence-harvest patterns from Alternative VIII would be most prominent among southern Kenai Peninsula communities and the communities of Nanwalek and Port Graham. These communities could experience subsistence-resource loss, primarily because of the high level of exposure to spills from transportation sources, should they occur. Such losses could include the lack of resource availability, accessibility, or desirability for use. Reductions in subsistence-harvest levels for specific resources could extend for a year or more. Elsewhere in Cook Inlet and on Kodiak Island and the Alaska Peninsula, effects on subsistence-harvest patterns are estimated to be limited in magnitude and duration and not of such a nature as to cause measurable changes in the availability, accessibility, or desirability of most subsistence resources.

Conclusion: Effects on subsistence-harvest patterns are expected essentially to be the same as Alternative I (base case), in that subsistence harvests would be reduced or substantially altered by as much as 50 percent in one or more southern Kenai Peninsula communities for at least 1 year and, to a lesser extent, for selected subsistence resources 2 to 3 years beyond. However, deferral of a substantial number of blocks north of Anchor Point could reduce the potential for effects on subsistence harvests.

k. Effects on Sociocultural Systems: The effect-producing factors for Alternative VIII, the Northern Deferral Alternative, include prelease and postlease planning processes, the introduction of industrial activities and changes in community population and/or employment levels, potential effects on subsistence-harvest patterns, and effects from accidental oil spills and cleanup efforts.

Effects on sociocultural systems begin with the prelease processes of announcing the proposed sale and carrying out the preparation of an EIS. Given a significant oil discovery, planning processes are again engaged to prepare a developmental EIS. Each of these sometimes lengthy processes cause stress and anxiety among affected publics, although the stakes would be different. The discussion under the base case (Sec. IV.B.1.k) explores the types of impacts involved.

The Northern Deferral Alternative has the same technical characteristics as the base case regarding the number and location of pipeline landfalls; the number and location of shore bases; and the number of exploration, delineation, and production rigs in operation per year. It differs from the base case in the number of exploration and delineation wells drilled (reduced from 8-5), the number of production platforms used (reduced from 3-2), the number of production wells drilled (from 48-29), and the amount of oil produced (from 200-140 MMbbl).

As discussed for the base case, it is more likely that the population associated with OCS-related industrial activities would be distributed within the central Kenai Peninsula area than according with the distribution of population established in the 1990 census of population. Accordingly, Table IV.B.8.k-1 shows this distribution to represent a percentage of increase in population for the mid-Peninsula area of about half that of the base case in the long term and about the same as the base case in the years 2000 and 2002. Consequently, effects on sociocultural systems from population increases generally should be the same as for the base case in that the effects on social and cultural institutions in this area of the Kenai Peninsula from population increase are even less than those imposed under the base case.

Effects on subsistence-harvest patterns from oil-spill events would be the same as the base case in that the number of spills estimated to occur and the production and transportation scenarios would be the same as or similar to the base case. Likewise, effects from oil-spill and cleanup events would be the same as for the base case. Although potential effects on subsistence may not be altered, deferral of all blocks north of Anchor Point should provide a psychological boost to the reduction of stress and anxiety from the visual threat from offshore activities in lower Cook Inlet waters as well as potential conflicts with commercial fisheries.

As a consequence of the above, effects on sociocultural systems from Alternative VIII would be centered on the Kenai Peninsula, including the Alutiiq communities of Nanwalek and Port Graham. Resident population associated with the sale would do little to change existing sociocultural systems in the central Kenai Peninsula area, where new

Table IV.B.8.k-1
Alternative Distribution of Sale-Related Resident Population within the Kenai Peninsula Borough (KPB): Mid-Peninsula Area; Alternative VIII

Year	Mid-Peninsula Total Resident Population without Sale	Sale-Related Resident Population	Mid-Peninsula Resident Population with Sale	Mid-Peninsula Percentage of Increase
1997	19,848	491	20,339	2.4
1998	20,027	673	20,700	3.3
1999	20,207	1,906	22,113	8.6
2000	20,389	2,895	23,284	12.4
2001	20,572	1,167	21,739	5.4
2002	20,757	2,966	23,723	12.5
2003	20,944	1,093	22,037	5.0
2004	21,133	1,107	22,240	5.0
2005	21,323	1,093	22,416	4.9
2006	21,515	1,093	22,608	4.8
2007	21,708	1,093	22,801	4.8
2008	21,904	1,093	22,997	4.8
2009	22,101	1,107	23,208	4.8
2010	22,300	1,132	23,432	4.8
2011	22,501	1,131	23,632	4.8
2012	22,703	1,093	23,796	4.6
2013	22,907	1,093	24,000	4.6
2014	23,114	1,093	24,207	4.5
2015	23,322	1,093	24,415	4.5
2016	23,531	1,094	24,625	4.4
2017	23,743	1,093	24,836	4.4
2018	23,957	1,093	25,050	4.4
2019	24,173	1,093	25,266	4.3
2020	24,390	1,093	25,483	4.3

Source: MMS, Alaska OCS Region.

resident population would be expected to live. Despite the limited chance that one or more oil spills ≥1,000 bbl would occur and contact land, the individual, social, and institutional effects from these and tanker spills, should they occur, could be serious. Individual and social stress and anxiety levels would be expected to increase in southern Kenai Peninsula communities over the loss of subsistence resources, contamination of habitat, fear of the health effects of eating contaminated wild foods, and the need to depend on the knowledge of others about environmental contamination.

In the Alutiiq communities, the organization of subsistence activities among kinship and friendship groups and the relationships among those that customarily process and share subsistence harvests also could be modified or could decline in importance. Stress-induced increases in alcohol and drug abuse would produce increases in numerous substance-abuse problems, such as child abuse, domestic violence, and accidents. The duration of individual and social effects would depend on the severity of the oil-spill experience. Institutionally, communities would undergo considerable disruption and community conflict, with litigation constituting a secondary source of postspill social and community stress. On the other hand, however, the absence of the visual threat from offshore activities in lower Cook Inlet waters and the threat of commercial fisheries conflicts would tend to reduce psychological stress and anxiety about post-lease offshore activities.

Conclusion: Effects on sociocultural systems essentially are expected to be the same as Alternative I (base case), in that one or more southern Kenai Peninsula communities would undergo periodic episodes of increased individual, social, and institutional stress and disruption that would last for several years in each instance and endure in memory for decades; effects are caused by both prelease and potential postlease processes and events. However, deferral of all blocks north of Anchor Point would tend to reduce stress and anxiety among residents of Kenai Peninsula communities due to the absence of a visual threat and the potential for fisheries conflicts.

l. Effects on Archaeological and Cultural Resources: Alternative VIII (Northern Deferral Alternative) should reduce effects on archaeological and cultural resources located in the deferral area, because it would lower the possibility of interaction from workers or the chance of contact from spilled oil. The activities associated with the discovery and production of oil included in the base case would be the same for this alternative but based on assumed resources of 140 MMbbl of oil. For Alternative VIII, the effects of an oil spill would not be lowered because the risk of contact from tanker and pipeline segments and, therefore, the risk of effect would not be removed for LS's 68 through 74, LS's 15 through 22, and LS's 32 through 36. An estimated 150 sites are in that area, and disturbance would be <3 percent, or <5 sites, the same as for the base case for the above-mentioned land segments (see Sec. IV.B.1.l).

Conclusion: It is estimated that this alternative would not result in a lowering of the effect of the base case. Less than 3 percent of the archaeological sites and shipwrecks (an estimated 5 sites) on the shore and within the State's 3-mi zone would be affected.

m. Effects on National and State Parks and Related Recreational Places: For Alternative VIII, the Northern Deferral Alternative, the field-development and infrastructure-construction activities associated with the assumed resources of 140 MMbbl of oil would result in effects not substantively different from those of the base case in that effects due to area use by additional population and related infrastructure generated by this alternative would be similar to those of the base case. Also for Alternative VIII, the effects of an oil spill would not be appreciably lowered. Use by visitors and probability of vandalism of the shore and intertidal zone habitats would be the same as in the base case.

Conclusion: It is anticipated that Alternative VIII would not result in a lowering of the population, infrastructure, or oil-spill-related effects of the base case. Less than 3 percent of the national and State parks and related recreational places would be affected for a period of <3 years.

n. Effects on Air Quality: Air-quality regulations and procedures are discussed in Section IV.B.1.n, the base case. That discussion also describes the methodology used to model the air-quality effects associated with this proposed lease sale. The USEPA-approved OCD model was used to calculate the effects of pollutant emissions due to the proposal on onshore air quality. Because the Class I PSD areas allow for the least amount of degradation, the modeling scenario (i.e., source location) chosen for this analysis is the one that results in the maximum potential effect to the air quality of the designated national wilderness area of the Tuxedni National Wildlife Refuge, the only Class I area adjacent to the proposed sale area. The maximum potential effect at any location in the Class II area would be the same. In all likelihood, effects to the Tuxedni National Wilderness Area would be lower than those calculated by the model.

For Alternative VIII, peak-year emissions from exploration would be from drilling one to two exploration wells and two to three delineation wells from one rig. Peak-year emissions from development would include platform and pipeline installation and the drilling of 20 production wells from two rigs. Peak-year production emissions would result from operations (producing 13 MMbbl of oil) and transportation. Table IV.B.1.n-1 lists estimated uncontrolled pollutant emissions for the peak-exploration, peak-development, and peak-production years. Due to the configuration of the deferral area, the sale area would be 33 km (20 mi) off Chisik Island (within the national wilderness area of the Tuxedni National Wildlife Refuge, the only Class I area adjacent to the sale area). This is significant because the air-quality modeling assumed maximum effect to the air quality of the national wilderness area. Alternative VIII provides a greater distance between the Class I area and the proposed action, thus reducing the already assessed minimal effect to air quality from the Alternative I base case.

Under the Federal and State of Alaska PSD regulations, because the estimated annual uncontrolled NO_2 emissions for peak-development year would exceed 250 tons per year, the lessee would be required to control NO_2 emissions through application of BACT to emissions sources to reduce NO_2 emissions (Table IV.B.1.n-2). The air-quality analysis performed using the OCD model for air pollutants emitted for exploration, development, and production under Alternative VIII showed that the maximum NO_2 concentration, averaged over a year, would be 0.19, 0.51, and 0.14 $\mu g/m^3$, respectively, at the shoreline; 7.6, 20.4, and 5.6 percent, respectively, of the available Class I increment for NO_2; and 0.76, 2.04, and 0.56 percent, respectively, for Class II. (Other pollutants also were modeled; however, NO_2 had the highest concentrations, which were well within PSD increments and air-quality standards.) The existing air quality would be maintained by a large margin.

For a more detailed discussion of the potential effects of air pollution—other than those effects addressed by standards—see Section IV.B.1.n. The amount of air pollutants reaching the shore is expected to be very low spatially and temporally because of the small amount of emissions from exploration, development, and production activities and their distance from shore. In addition, the probability of experiencing one or more blowouts in drilling the 29 wells projected for Alternative VIII would be 8 to 11 percent. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore due to exploration and development/production or accidental emissions would not be sufficient to harm vegetation. A light, short-term coating of soot over a localized area could result from oil fires. Consequently, the effects of air-pollutant emissions under Alternative VIII are expected to be minimal.

Conclusion: The effects associated with this alternative essentially would be the same, qualitatively, as those discussed for the Alternative I base case. Alternative VIII provides reduction in air-quality effects to onshore resources due to the deferral of areas nearshore from potential exploration, development, and production activities. Effects on onshore air quality analyzed for Alternative VIII are expected to be 20.4 percent of the maximum allowable PSD Class I increments. Only the Tuxedni National Wilderness Area is designated Class I, with the remaining area in and adjacent to the sale area designated Class II. Therefore, the potential effects would be much less. These effects would not make the concentrations of criteria pollutants in the onshore ambient air approach the air-quality standards. Consequently, a minimal effect on air quality with respect to standards is expected. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore from exploration, development, and production activities and accidental emissions would not be sufficient to harm vegetation. A light, short-term coating of soot over a localized area could result from offshore oil fires.

o. **Effects on Coastal Zone Management:** Conclusions for biological resources in Section IV.B.8 indicate that this alternative, the Northern Deferral Alternative, would delete 117 blocks north of Anchor Point, and could provide localized reduction in oil-spill risk for important coastal habitats in Cook Inlet and northern Shelikof Strait. Effects on subsistence are not expected to be reduced significantly. Statewide standards and associated district policies assessed in the base case include coastal development; geophysical-hazard areas; recreation; energy facilities; transportation and utilities; fish and seafood processing; subsistence; habitats; air, land, and water quality; and historic, prehistoric, and archaeological resources. Potential conflict with many of these Statewide standards and the associated district policies is unknown until a specific plan is submitted. However, a potential for conflict with the Statewide habitat standard was identified in the base case. Conflict resulted from the effects of seismic activities and oil spills in the offshore environment on commercial fishing. The ACMP provides a format for mitigating these potential conflicts. The MMS operating procedures and the mitigating measures associated with this sale—especially the ITL clauses for Oil-Spill-Contingency Response, Bird and Marine Mammal Protection, Sensitive Areas to be Considered in Oil-Spill-Contingency Plans, Coastal Zone Management, and the stipulations on Density Restrictions Related to Commercial Fishing Uses, and Minimizing Potential Conflicts Between Oil and Gas Industry and Fishing Activities—provide additional mechanisms to ensure that activities that may follow this sale avoid conflict with the ACMP.

Conclusion: Potential conflict with the Statewide standard on habitats is possible. Site-specific information is necessary to ensure there is no conflict with the policies related to coastal development; geophysical hazards; energy-facility siting; transportation and utilities; subsistence; air, land, and water quality; and historic, prehistoric, and archaeological resources. Conflict is not inherent in the scenario.

9. Alternative IX, Kennedy Entrance Deferral Alternative:

Description of Alternative IX: This alternative would offer for leasing 385 blocks (1.88 million acres) located in the central part of the planning area in lower Cook Inlet (Fig. II.H.1). The subarea removed by the deferral alternative consists of 17 whole and partial blocks (100,000 acres), about 5 percent of the proposed sale area. The blocks proposed for deferral lie off the southwestern tip of the Kenai Peninsula and west of the Barren Islands. Deletion of the blocks near the western end of Kennedy Entrance was suggested by the State of Alaska. The deferral of northern blocks would reduce the risk of oil spills contacting subsistence-harvest areas used by the Native communities of Port Graham and Nanwalek, and the deferral of both areas would reduce potential conflicts with commercial fisheries. Both the northern set of blocks (located off the southwestern end of the Kenai Peninsula) and the southern set (located west of the Barren Islands) were part of Alternatives V and VII (Figs. II.E.1 and II.G.1, respectively); and the southern set of blocks also was part of Alternative IV (Fig. II.D.1).

Resource Estimates and Basic Exploration, Development, and Production Transportation Assumptions for Effects Assessment: The resources for this alternative are assumed to be 200 MMbbl, the same as Alternative I. Accordingly, resource-exploration and -developmental time frames for oil activity also would be the same as the Proposal. Please see Table IV.A.1-1.

Probability of One or More Spills Greater than or Equal to 1,000 Barrels Occurring: For this deferral alternative, the probability of one or more spills ≥1,000 bbl occurring is the same as Alternative I (base case)—27 percent. The probability of one or more spills ≥1,000 bbl from (1) platforms is 12 percent, (2) pipelines is 13 percent, and (3) tankers is 6 percent, the same as Alternative I (base case) (Appendix B, Table B-1).

a. Effects on Water Quality:

For Alternative IX, the activities associated with petroleum exploitation most likely to affect water quality in the CI/SS sale area are (1) the permitted discharges from exploration-drilling units and production platforms, (2) accidental oil spills, and (3) construction activities. The Kennedy Entrance Deferral Alternative is estimated to have the same economically recoverable oil resources assumed for Alternative I (base case)—200 MMbbl. The types of activities associated with exploiting the potential oil resources of this alternative are the same as for Alternative I (base case) (Table II.A.1). The types and levels of activities include the number of wells drilled and quantities of muds and cuttings discharged, the number of production platforms and the types and quantities of discharges, the number of pipeline miles, and the number of oil spills and the amount spilled (Tables II.A.2-1, II.A.2-2, IV.A.2-2, and IV.A.2-4). The characteristics of the discharges, spills, and activities and their potential effects on water quality are described in Section IV.B.1.a and summarized in this section.

The benefits of this deferral alternative are derived from the exclusion of exploration-drilling units and production platforms from locating in the deferred areas—about 5 percent of the Sale 149 area; these areas are shown in Figure II.I-1. Excluding the drilling units and production platforms from the deferred areas eliminates the direct release of the permitted discharges into the waters of these areas.

The hydrodynamic processes in the Cook Inlet Planning Area suggest the water column generally is well mixed, and dilution would reduce the concentration of the substances in the discharges. Degradation processes also act to continuously reduce the concentrations of many substances deliberately or accidentally released into the environment.

Of the permitted discharges, drilling muds and cuttings and produced waters are the most significant discharges associated with offshore operations. The permitted discharges would add substances that may be foreign to or increase the concentration of constituents already present in the water column of CI/SS. This analysis will consider (1) the chronic criterion (for the protection of marine life) for SPM/turbidity to range from 100 to 1,000 mg/l (Sec. IV.B.1.a(1)(a)1)); (2) 15 μg/l to be the chronic criterion (for the protection of marine life) and 1,500 μg/l—a hundredfold higher level—to be the acute criterion for total hydrocarbons (Sec. IV.B.1.a(1)(b)2)a)); and (3) 10 μg/l to be the chronic criterion (for the protection of marine life) and 1,000 μg/l to be the acute criterion for TAH (Sec. IV.B.1.a(1)(b)2)a)). In general, the added substances may cause sublethal effects in some marine organisms if concentrations are greater than the chronic criteria and lethal effects if concentrations are greater than the acute criteria.

Drilling of the 3 exploration, 5 delineation, and 48 production and service wells could result in the discharge of an estimated 6,720 to 20,640 tons (dry weight) of drilling-mud components and 30,400 tons (dry weight) of cuttings (Table IV.B.1.a-2). The concentrations of discharged drilling muds initially may range from about 1,000 to 2,000 g/l and are expected to be greater than the SPM turbidity chronic criteria, 100 to 1,000 mg/l, assumed for this analysis. However, within about 100 to 200 m of the discharge point, mixing in the water column would reduce the concentrations by a factor of 10,000 to 1,000,000; the diluted concentrations are estimated to range from 1 to 200 mg/l. The concentration of suspended particulate matter in lower Cook Inlet and Shelikof Strait ranges from about 1 to 50 mg/l. Most of the solids in the discharges settle rapidly to the seafloor, where bottom currents disperse the finer particles. The drilling discharges are expected to take place over a 5- or 6-year period—most of the discharges would occur in the last 3 years and be associated with the drilling of the production and service wells.

Produced waters constitute the largest source of substances discharged into the marine environment, and their discharge is an issue of significant concern because of the types and amounts of naturally occurring substances they may carry and the manmade substances that may be added. The amount of produced water that would be discharged as a consequence of producing an assumed 200 MMbbl of oil in 19 years is estimated to range from about 18 to 148 MMbbl or more (Table IV.B.1.a-2). The toxicity of produced waters mainly is caused by hydrocarbons that include nonvolatile hydrocarbons (USEPA oil and grease) and aromatic hydrocarbons. The discharges associated with production activities are expected to last for the life of the field(s), at least 19 years, and the rates increase with time. The concentrations of nonvolatile hydrocarbons and TAH in the produced waters are estimated to range from 19 to 36 mg/l (19,000-36,000 μg/l) and 8 to 13 mg/l (8,000-13,000 μg/l), respectively.

The dilution rates for the produced waters are estimated to range from about 1,000:1 to 1,000,000 within several hundred meters of the discharge site. If dilutions are based on a rate of 1,000:1, the concentrations of nonvolatile hydrocarbons (oil and grease) within several hundred meters of the platform might range from 19 to 36 μg/l and the concentrations of TAH might range from 8 to 13 μg/l. These concentrations are well below the acute criteria of 1,500 μg/l for the nonvolatile hydrocarbons and 1,000 μg/l for the TAH that were assumed for this analysis but, in general, slightly greater than the chronic criteria of 15 μg/l for the nonvolatile hydrocarbons and 10 μg/l for the TAH. If dilution rates are about 10,000:1, the concentrations of nonvolatile hydrocarbons might range from about 2 to about 4 μg/l and the concentrations of TAH might be about 1 μg/l; these concentrations are less than the respective chronic criteria assumed for analysis. When discharged, the toxicity of the produced waters is expected to range from slightly toxic to practically nontoxic and will decrease with continued mixing in the water column.

The characteristics of the other constituents of the produced waters or other production-related discharges are expected to be within the USEPA criterion and/or be diluted in the water column within an area <2 km^2 to background concentrations or levels that would not cause sublethal to lethal effects in marine organisms.

The potential effects in any of the areas where there are permitted discharges would last for about (1) 2 to 3 months for each exploration well drilled and (2) 22 years for development and production activities. Future procedures and technologies of treating and handling drilling muds and cuttings and produced waters may reduce or eliminate the amounts discharged.

Accidental oil spills introduce into the water column a variety of hydrocarbon compounds whose concentrations may cause sublethal to lethal effects in marine organisms. Hydrodynamic and meteorological forces increase the areal extent of the spill and physical, chemical, and microbiological forces degrade the oil and reduce its concentration and toxicity.

The number of small (<1,000-bbl) accidental oil spills that might occur if oil is produced is estimated to be 49; the total volume of oil spilled is estimated to be 555 bbl (47 spills that average 5 bbl in size and two 160-bbl spills) (Tables IV.A.2.4b and 4c). At the end of 3 days assuming no cleanup, the oil from a small spill may be dispersed in a 1- to 10-square kilometer (km^2) area in concentrations of about 20 to 61 μg/l. The concentration of the dispersed oil 10 days after a spill is estimated to be between 3 and 14 μg/l in an area of about 9 to 48 km^2 and, after 30 days, <1 to about 1 μg/l in an area of 34 to 199 km^2. During the 3- to 30-day interval following a small spill, the concentration of oil in the water column is not expected to exceed the total hydrocarbon acute criterion, 1,500 μg/l, assumed for this analysis; however, the concentration of spilled oil is expected to exceed the assumed total hydrocarbon chronic criterion, 15 μg/l, for several days to weeks.

amounts > 15 μg/l) would be temporary (last for a month, or more) and affect an area of several thousand square kilometers.

b. **Effects on Lower Trophic-Level Organisms**: Routine activities associated with the Kennedy Entrance Deferral Alternative (Alternative IX) that may affect lower trophic-level organisms include seismic surveys, drilling discharges, and dredging or construction. Accidental activities include exposure to petroleum-based hydrocarbons from an oil spill. The effects of these routine and accidental activities on lower trophic-level organisms are discussed in the base case (Sec. IV.B.1.b) and are summarized below. The following analysis for Alternative IX focuses on the differences in the amount of activity (the only variable) estimated for Alternative IX, as compared to that of the base case. It then estimates the resulting effect of this difference on lower trophic-level organisms for Alternative IX.

This alternative would delete 17 blocks, or about 5 percent of the sale area discussed in the base case. This eliminates any OCS activity in the deferral areas and would eliminate them as areas where a platform oil spill could originate. However, platforms outside the deferral areas would remain as a potential oil-spill source, and would be likely to affect the southern to mid portion of the deferral area. More importantly, the probability of one or more oil spills occurring from an oil tanker or pipeline (the primary oil-spill sources) for the deferral area is nearly the same as that of the base case. Hence, in terms of an oil spill, the essential difference between Alternative IX and the base case is the extra time it would take for a platform (now outside of the deferral areas for Alternative IX) spill to reach deferral-area shorelines. This extra time would reduce the amount of toxic hydrocarbons reaching deferral-area shorelines. However, the surface oil (the most damaging aspect of spilled oil) still would reach these shorelines. Further, because of the speed of water movement in Cook Inlet/Shelikof Strait, the reduction in toxicity that would occur while the oil was traversing the deferral areas may be relatively small, depending on where the spill originated. For these reasons, and because there only would be a minor change from the base case in the probability of an oil spill from the primary oil-spill contributors (tankers and pipelines), the effects of Alternative IX on lower trophic-level organisms are expected to be essentially the same as discussed for the base case, and are summarized below.

Seismic surveys are expected to have little to no effect on lower trophic-level organisms. Drilling discharges are estimated to affect < 1 percent of the benthic organisms in the sale area and none of its plankton. Recovery is expected to occur within 1 year. Dredging and construction are expected to have little or no effect on plankton communities. Less than 1 percent of the immobile benthic organisms would be affected. Immobile benthic communities affected by pipeline construction are expected to recover in < 3 years. The effects of petroleum-based hydrocarbons on phytoplankton, zooplankton, and benthic organisms range from sublethal to lethal. Where flushing times are longer and water circulation is reduced (e.g., bays, estuaries, and mudflats), adverse effects are expected to be greater, and the recovery of the affected communities is expected to take longer. Large-scale effects on plankton due to petroleum-based hydrocarbons have not been reported. Assuming that a large number of phytoplankton were contacted by an oil spill, the rapid replacement of cells from adjacent waters and their rapid regeneration time (9-12 hours) would preclude any major effect on phytoplankton communities. Observations in oiled environments have shown that zooplankton communities experienced short-lived effects due to oil. Affected communities appear to rapidly recover from such effects because of their wide distribution, large numbers, rapid rate of regeneration, and high fecundity. Large-scale effects on marine plants and invertebrates due to petroleum-based hydrocarbons have not been reported. The sublethal effects of oil on marine plants include reduced growth and photosynthetic and reproductive activity. The sublethal effects of oil on marine invertebrates include adverse effects on reproduction, recruitment, physiology, growth, development, and behavior (feeding, mating, and habitat selection).

Based on the assumptions discussed in the text (see Sec. IV.B.1.b), the assumed oil spill for Alternative IX is estimated to have sublethal and lethal effects on 1 to 5 percent of the phytoplankton and zooplankton populations in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 1 week for zooplankton. The total percentage of plankton affected could increase to 5 percent if many embayments were contacted by the spill. Recovery within the affected embayments is expected to take 1 to 2 weeks. Marine plants and invertebrates in subtidal areas are not likely to be contacted by an oil spill, but marine plants and invertebrates in intertidal and shallow subtidal areas are likely to be contacted by an oil spill. Based on the assumptions discussed in the text (see Sec. IV.B.1.b), the assumed oil spill for Alternative IX is estimated to have lethal and sublethal effects on about 20 to 30 percent of the intertidal and shallow subtidal marine plants and invertebrates in the sale area. Recovery of these communities is expected to take 2 to 3 years in high-energy habitats and up to 7 years in lower energy chance of contact are removed and some, but not all, hypothetical production-spill sites with a >25-percent and <50-percent chance of contact within 30 days during summer or winter are removed.

Although some risk of contact is reduced under this alternative, the overall estimated spill effects would be unchanged from the base case. Adult salmon and steelhead should not be affected. Oiled intertidal areas have the potential for increased mortality to pink salmon eggs, and some juvenile pink salmon could have slower growth rates from ingestion of oil-contaminated food. There could be an increased level of developmental malformations and increased egg-larval mortality in herring. Eggs and larvae of some demersal and semidemersal fish also could suffer some increased mortality. The short-term, local effects of noise disturbance and habitat alteration would be lessened for the fisheries resources in the deferral area. These include outmigrating salmonid smolts along western and eastern Cook Inlet; pink salmon populations within Kachemak Bay; and demersal fishes, primarily halibut and cod, around the Barren Islands to Cape Douglas.

Conclusion: Compared to the base case, the estimated spill effects would be unchanged, with the potential for increased mortality in pink salmon eggs and an increased level of developmental malformations and increased egg-larval mortality in herring. Eggs and larvae of some demersal and semidemersal fish also could suffer some increased mortality. Potential noise and disturbance effects to these fishery resources due to exploration and production in these areas also would be eliminated. The various effects to fisheries resources taken altogether are not expected to cause population-level changes.

d. **Effects on Marine and Coastal Birds:** Alternative IX, the Kennedy Entrance Deferral, would remove approximately 17 whole and partial blocks (5% of the sale area) from the proposed lease sale. This alternative would provide some protection from potential platform spills to the Barren Islands and Kachemak Bay/lower Kenai Peninsula, important habitats of marine and coastal birds.

Based on the summer 30-day conditional risk contours, this alternative would eliminate most hypothetical platform-spill locations with an estimated >25 and <50-percent chance of contacting the Barren Islands seabird-concentration area (ERA 6) and all hypothetical production-platform spill sites with a >50-percent chance of contact to ERA 3, Kachemak Bay (Appendix B and Fig. II.I-1 Alternative IX).

Thus, some limited reduction of oil-spill risks on seabirds nesting on the Barren Islands and on seabirds, sea ducks, and shorebirds and their habitats in Kachemak Bay and other nearshore habitats in lower Kenai Peninsula are expected to occur under this alternative. However, the probabilities of occurrence and contact to other coastal habitats of marine and coastal birds in lower Cook Inlet still are high enough to expect that the assumed 50,000-bbl-oil spill would occur and contact at least one or more of the environmental resource areas (important habitats of marine and coastal birds) affecting several thousand to perhaps 100,000 birds. If a tanker spill occurred in the Kennedy Entrance to Cook Inlet or in the Gulf of Alaska, the Barren Islands' seabird-colony-concentration area is expected to be contacted by the spill, and several thousand or more seabirds are expected to be lost. Thus, the potential oil-spill effects to the Barren Islands' seabird-colony complex and to other marine and coastal birds and their habitats in lower Cook Inlet are expected to remain about the same as for the Proposal.

Noise and disturbance and habitat-alteration effects on marine and coastal birds are expected to be the same as described under the Alternative I base case, because the transportation scenario and levels of exploration and development activities for this alternative are expected to be the same as for the Proposal.

Conclusion: The overall effect of Alternative IX on marine and coastal birds (the loss of several thousand to perhaps 100,000 birds, with recovery taking >1 to 3 generations) is expected to be about the same as described under the base case. Oil-spill effects from production platforms on bird populations potentially could be reduced locally on the Barren Islands and Kachemak Bay.

e. **Effects on Nonendangered Marine Mammals (Pinnipeds, Cetaceans, and the Sea Otter):** This deferral (Alternative IX) removes 17 lease blocks from the sale area near the Kennedy Entrance. This reduces the probability of a spill from platforms and reduces the amount of noise and disturbance in and around certain coastal fisheries resources and wildlife areas. The effect of this deferral alternative will be examined using 30-day conditional risk contours during the summer and winter on the most sensitive marine mammal resource areas in the sale area that could be affected under the base case. Effects on marine mammals from (1) oil spills and years. Potential noise and disturbance effects to these marine mammals due to exploration and production in these areas also would be eliminated by the deferral alternative.

f. Effects on Endangered and Threatened Species: Alternative IX (Kennedy Entrance Deferral) would provide buffers in the southeastern sale area northwest of the Barren Islands and west of the Kenai Peninsula. These buffers lie within the zone of probable seasonal occurrence of endangered whale species, and areas potentially used by foraging or rafting Steller sea lions occupying the major rookery or haulouts in the Barren Islands. This alternative removes approximately 15 percent of the limited southern sale area within which, under Alternative I (Proposal, Sec. IV.B.1.f), a small proportion of these species' populations potentially could be exposed to routine exploration or development/production activities.

For these populations, the most likely sources of potentially adverse effects associated with routine activities are disturbance (including drilling operations, aircraft and vessel traffic, and seismic surveys), and release of drilling muds and cuttings. The buffer created by removing lease blocks from the sale area would be expected to reduce effects of activity somewhat in these areas as a result of the greater distance between potential platform sites and wildlife concentrations. However, as discussed for Alternative I, potential effects from routine activities already are likely to be minimal because of the expectation that travel routes of few whales or sea lions will intersect those of vessels or aircraft, or approach a platform, and that any interaction effects (e.g., travel-direction change, area avoidance) will last for less than an hour. Likewise, exposure of whales or sea lions, or their prey species, to any materials (e.g., muds and cuttings) released into the environment is expected to have minimal effects due to rapid dispersal of such materials to nontoxic concentrations in this oceanographically dynamic area.

The buffer created by removing these blocks from the sale area would not reduce the estimated probability of one or more oil spills occurring from that under Alternative I (27%, Table IV.A.2-2) because projected oil resources are the same; however, Alternative IX would be expected to reduce potential effects somewhat in the southern portion of lower Cook Inlet, the Barren Islands area, and northern Shelikof Strait as a result of the additional weathering and cleanup that could occur as spilled oil moves through the greater distance between potential platform-spill sites and wildlife concentrations. Specifically, deferral of blocks northwest of the Barren Islands (ERA 6) would eliminate some hypothetical production-spill sites from which there is at least a ≥25- and <50-percent chance of contact during summer after 30 days (Appendix B, Fig. B-6). While removal of the platform contribution to spill risk from these blocks is expected to reduce the risk of spill contact in this sea lion intensive-use area somewhat, the relation of pipeline and tanker routes to the area, and thus the risk from these sources, remains essentially unchanged from Alternative I: the conditional probability (expressed as percent chance) of spilled-oil contact ranges from 55 percent from tanker segment T4 (Appendix B, Table B-4) to <0.5 percent from more distant sites (T1), but from most potential spill sites it is <20 percent (Table B-4). Similar arguments can be made for ERA's 7, 9, and 12 in Shelikof Strait, where hypothetical production-spill sites with ≥50 and <75, ≥25 and <50, ≥5 and <25 percent chance of contact, respectively, are removed. The combined probability (expressed as percent chance) of one or more ≥1,000-bbl oil spills from these sources, or from a platform outside the buffer, occurring and contacting sea lion use areas in the vicinity of the southern portion of the sale area is reduced slightly from Alternative I (≤4% to ≤3%, ERA's 5-9), and remains <0.5 percent (ERA's 10-13) to the south (Appendix B, Tables B-14, B-15; Fig. IV. A.2-6), so the risk to sea lions is expected to remain essentially as discussed under Alternative I: the potential loss of a few tens of individuals requiring at least one generation for recovery. This alternative would not reduce potential effects on wintering Steller's eiders from those discussed for Alternative I (2 generations required for recovery from oil-spill losses).

Deferral of blocks from the southeastern sale area may provide some limited relief from disturbance and possible contact with drilling muds and cuttings, and any oil spilled for the small numbers of endangered whales, and Steller sea lions, that pass through or occupy the southeastern portion of the proposed sale area by removing potential platform sites and associated support activities farther from migration routes and foraging areas in the Barren Islands. Thus, potential effects under this alternative are expected to be reduced to a limited extent from those discussed under Alternative I, which include: (1) exposure of ≤1 percent of the North Pacific fin whale and 5 percent of humpback whale populations occurring in this area to disturbance, with individuals being affected for an hour or less per incident; (2) similarly small numbers of whales exposed to an oil spill, with any effects sublethal and short term; (3) a tanker spill outside entrances to Cook Inlet/Shelikof Strait contacting larger numbers of whales east of Kodiak Island, but without the occurrence of any mortality; (4) less than 2 percent of the central Gulf of Alaska Steller sea lion population (5% of the potentially affected area population) exposed to potentially disturbing activities with no rookeries or haulouts likely to be disturbed; (5) an oil spill potentially contacting up to shore base constructed between 1997 and 2001, and 125 mi of offshore pipeline in the year 2002. Also generating employment would be the production of 200 MMbbl of oil.

For Alternative IX, direct OCS resident employment on the western side of the Kenai Peninsula would start with about 324 in 1997 and 1998; rise to about 694 in 1999 and to about 1,154 in 2000 and about 1,463 in 2001; drop to about 1,320 in 2002; drop to about 849 in 2003; and vary between about 834 and 849 through 2020. Indirect resident employment is estimated to be 12.6 percent of direct OCS-resident employment and would peak at about 184 for the year 2001. (See Appendix G for a description of methodology for employment and population forecasts.)

Most initial workers are anticipated to come from outside the region; some may come from inside the region. The rate of unemployment in the region at the time of demand for OCS workers will be important in determining the ratio of local to outside workers. It is anticipated that in at least the early years of OCS activity for the base case, many workers trained in oil-industry skills would be living on the Kenai Peninsula. Many would have worked on the North Slope or in Cook Inlet. The availability of workers experienced in the oil industry and living on the Kenai Peninsula—when demand for this type of labor is generated by Sale 149—would be determined by the unemployment among them.

It is assumed for Alternative IX that there would be no enclave employment, and that all workers would reside on the western side of the Kenai Peninsula. However, for peak years of development it is assumed that approximately half the workers would be housed in temporary quarters provided by the OCS lessee. Resident employment on the western side of the Kenai Peninsula is estimated to be 15,986 for 1995 and is projected to rise 0.9 percent annually without the sale. Between the years 1997 and 2002, direct OCS employment and indirect employment would increase and decrease between zero and 3 percent of total employment each year.

The OCS activity could generate effects on other facets of the economy including income, prices, and taxes. The OCS workers are likely to earn relatively high wages compared to the average income on the western part of the Kenai Peninsula. Even assuming that the income of the OCS workers was twice as high as the average for the western Kenai Peninsula, the effect on the average income would be to change it by <3 percent for <5 years. This is because the largest rise for 1 year in direct OCS employment is 370 workers in 1999 compared to resident employment of 16,422 in 1998.

The <3-percent rise in average income for <5 years is the basic economic driving force of price inflation. The maximum rise in resident employment of <3 percent for 1 year, even assuming that the average income is twice the average for the Kenai Peninsula Borough (KPB) for 694 direct OCS workers, translates to price inflation of <3 percent for <5 years for the western Kenai Peninsula. Approximately half of the inflationary pressure will be in the demand for housing brought on by the fast rise in OCS workers with relatively high incomes. This inflationary pressure is lessened significantly by the assumption that about half the construction workers will be housed in temporary quarters. After 2 years of exploration and delineation (1997-1998), there are 3 years (1999-2001) of construction of the shore base and pipelines, installation of the platforms, and drilling of the wells. This brings a large increase in OCS employment in the period 1998 to 2003. The projected number of OCS workers for the base case rises precipitously from 324 in 1998 to 1,463 in 2001 and drops to 849 in 2003, at which level it remains to the year 2020. Because housing would be needed for the large number of OCS workers in the exploration and development phases for a relatively short period—6 years—it is assumed that temporary housing would be provided by OCS lessees for approximately half of the OCS workers in these peak years. The year 2000 would have the highest number of OCS workers –1,463; and temporary housing would be provided for about 730 OCS workers and permanent housing for the other 730 OCS workers.

Revenue from property tax would increase <2 percent for <5 years for the KPB. The value of taxable improvements to property during a peak year is estimated to be $50 million (1993 dollars), which is 1.6 percent of the total taxable valuation for the KPB in 1993 (Barnes, 1993, personal comm.). Primary components of taxable improvements are improvements in existing facilities equivalent to a new shore base and new housing for workers. These would be constructed primarily in the years 1997 to 2001. It is assumed that 200 permanent housing units would be built for each year for the 4 years following exploration, 1999 to 2002. At an average value in 1993 dollars of $100,000 per housing unit, the average value of new housing per year would be $20 million. The value of improvements to shore-base facilities is estimated to be $30 million (1993 dollars) for the peak year.

This alternative would delete 17 blocks, or about 5 percent of the sale area discussed in the base case. This eliminates any OCS activity in the deferral areas and would eliminate them as areas where a platform oil spill could originate. However, platforms outside the deferral areas still would be a potential oil-spill source that could affect the deferral areas. Also the probability of one or more oil spills occurring from an oil tanker or pipeline for the deferral area is likely to be similar to or the same as that of the base case. Hence, in terms of an oil spill, the only difference between this alternative and the base case is the extra time it would take for a platform (now outside of the deferral areas for Alternative IX) spill to reach the deferral areas. While this extra time likely would reduce the toxicity of the oil entering the deferral areas, it would not be likely to reduce economic losses to the commercial-fishing industry due to closures. For these reasons, the effects of oil spills associated with Alternative IX on the commercial-fishing industry are expected to be essentially the same as discussed for the base case; they are summarized below.

Drilling discharges associated with Alternative IX are not expected to have an effect on commercial fishing due to the limited area affected near the platform-discharge point. Offshore construction, platforms, and pipelines are expected to result in some space-use conflicts (e.g., competition for docking space or gear loss); however, these are expected to be few in number and minor in scope. Seismic surveys, planned and coordinated with the commercial-fishing industry, are expected to have a minimal effect on the commercial-fishing industry. Due to the relatively small amount of oil involved (555 bbl), the 49 small oil spills (Table IV.A.2-4d) assumed for Alternative IX are not expected to result in closures or reduced market values over the life of the proposal. Hence, they are not expected to have a measurable economic effect on the commercial-fishing industry. However, the assumed large (50,000-bbl) base-case oil spill is expected to affect pot, longline, trawl, drift-gillnet, and set-gillnet fisheries in Cook Inlet and Kodiak.

The estimated economic effect of the base-case oil spill on the Cook Inlet and Kodiak commercial-fishing industries is based on what occurred during the EVOS and GBOS, and primarily depends on the highly variable EVOS cost estimates (ranging from $9-43 million/year for 2 years). From 1983 to 1993, the value of the Cook Inlet commercial fishery appears to have ranged between about $50 and $135 million/year. Based on the above, in any 2-year period when the value of the Cook Inlet commercial fishery is estimated to be about $50 million/year, a 2-year loss of about $9 million/year represents an 18-percent/year loss for 2 years; whereas a 2-year loss of about $43 million/year represents an 85-percent/year loss for 2 years. In a 2-year period when the value of the Cook Inlet commercial fishery is estimated to be closer to $135 million/year, a 2-year loss of about $9 million/year represents a 7-percent/year loss for 2 years; whereas a 2-year loss of $43 million/year represents a 32-percent/year loss for 2 years. Because the occurrence of a large oil spill would preclude any knowledge of what the commercial fishery would have been worth, the value of the commercial fishery at the time of the assumed 50,000-bbl-oil spill is assumed to be the average annual value (1983-1993) of the Cook Inlet commercial fishery. Thus, in terms of the average annual value of the Cook Inlet commercial fishery (about $65 million), the assumed base-case oil spill is estimated to result in an economic loss of about 15 to 65 percent/year for 2 years. Estimated losses to the Kodiak commercial-fishing industry are expected to be less than half of that estimated for Cook Inlet, or about 5 to 25 percent/year for 2 years following the assumed 50,000-bbl Cook Inlet oil spill. This amounts to an estimated loss of about $4 to $19 million/year to the Kodiak commercial-fishing industry. However, the EVOS experience has demonstrated that compensation to the commercial-fishing industry for participating in the cleanup of a large Cook Inlet oil spill is likely to exceed these economic losses by several orders of magnitude.

Conclusion: Based on the assumptions discussed in the text (i.e., a 50,000-bbl spill occurs during the commercial-fishing season), EVOS-loss estimates, and the average annual value of the Cook Inlet and Kodiak commercial fisheries, the Kennedy Entrance Deferral Alternative is estimated to result in economic losses to the Cook Inlet commercial-fishing industry ranging from about 15 to 65 percent/year for 2 years following the assumed 50,000-bbl-oil spill. Losses to the Kodiak commercial-fishing industry from the same spill are estimated to range from about 5 to 25 percent/year for 2 years following the spill. The chance of one or more oil spills ≥1,000 bbl is estimated to be 27%.

j. Effects on Subsistence-Harvest Patterns: The effects-producing factors for Alternative IX, the Kennedy Entrance Deferral Alternative, are the same as for the base case, including routine operations such as seismic surveys, the disposal of drilling muds and cuttings, and the operation of support facilities, as well as accidental events such as oil spills.

As discussed for the base case, it is more likely that the population associated with OCS-related industrial activities would be distributed within the central Kenai Peninsula area than according with the distribution of population established in the 1990 census of population. Consequently, effects on sociocultural systems from population increases should be the same as for the base case.

Deferral of 17 blocks near the Barren Islands and offshore the community sites of Nanwalek and Port Graham reduces the potential for oil-spill effects from production sites on subsistence harvests in these communities and therefore should reduce to an unknown extent the stress and anxiety that accompanies such events. Removal of potential production sites farther offshore also increases the time available to respond to an accidental oil spill from a production platform, should such an accident occur. Additionally, the removal of potential production sites farther offshore in lower Cook Inlet should reduce the degree of the ever-present reminder of danger from oil spills that the platforms represent to some residents of the area.

As a consequence of the above effects on sociocultural systems in Alternative IX would be centered on the Kenai Peninsula, including the Alutiiq communities of Nanwalek and Port Graham. Resident population associated with the sale would do little to change existing sociocultural systems in the central Kenai Peninsula area, where new resident population would be expected to live. Despite the limited chance that one or more oil spills ≥1,000 bbl would occur and contact land, the individual, social, and institutional effects from these and tanker spills, should they occur, could be serious. Individual and social stress and anxiety levels would be expected to increase in southern Kenai Peninsula communities over the loss of subsistence resources, contamination of habitat, fear of the health effects of eating contaminated wild foods, and the need to depend on the knowledge of others about environmental contamination. In the Alutiiq communities, the organization of subsistence activities among kinship and friendship groups and the relationships among those that customarily process and share subsistence harvests also could be modified or could decline in importance. Stress-induced increases in alcohol and drug abuse would produce increases in numerous substance-abuse problems, such as child abuse, domestic violence, and accidents. The duration of individual and social effects would depend on the severity of the oil-spill experience. Institutionally, communities would undergo considerable disruption and community conflict, with litigation constituting a secondary source of postspill social and community stress.

<u>Conclusion</u>: Effects on sociocultural systems essentially are expected to be the same as Alternative I (base case), in that one or more southern Kenai Peninsula communities would undergo periodic episodes of increased individual, social, and institutional stress and disruption that would last for several years in each instance and endure in memory for decades; effects are caused by both prelease and potential postlease processes and events. However, deferral of a considerable number of blocks near shoreline and island groups should reduce stress and anxiety to some extent.

l. Effects on Archaeological and Cultural Resources: The activities associated with the discovery and production of oil included in the base case would be the same for this alternative, based on assumed resources of 200 MMbbl of oil. For Alternative IX, the effects of an oil spill would not be lowered because the risk of contact from tanker and pipeline segments and, therefore, the risk of effect would not be removed for LS's 68 through 74, LS's 15 through 22, and LS's 32 through 36. An estimated 150 sites are in that area, and disturbance would be <3 percent, or <5 sites, the same as for the base case for the above-mentioned land segments (see Sec. IV.B.1.l).

<u>Conclusion</u>: It is estimated that this alternative would not result in a lowering of the effect of the base case. Less than 3 percent of the archaeological sites and shipwrecks (an estimated 5 sites) on the shore and within the State's 3-mi zone would be affected.

m. Effects on National and State Parks and Related Recreational Places: For Alternative IX, the Kennedy Entrance Deferral, the field-development and infrastructure-construction activities associated with the assumed resources of 200 MMbbl of oil would result in effects not substantively different from those of the base case in that effects due to area use by additional population and related infrastructure generated by this alternative would be similar to those of the base case. Also for Alternative IX, the effects of an oil spill would not be appreciably lowered. Use by visitors and probability of vandalism of the shore and intertidal zone habitats would be the same as in the base case.

and seafood processing; subsistence; habitats; air, land, and water quality; and historic, prehistoric, and archaeological resources. Potential conflict with many of these Statewide standards and the associated district policies is unknown until a specific plan is submitted. However, a potential for conflict with the Statewide habitat standard was identified in the base case. Conflict resulted from the effects of seismic activities and oil spills in the offshore environment on commercial fishing. The ACMP provides a format for mitigating these potential conflicts. The MMS operating procedures and the mitigating measures associated with this sale—especially the ITL clauses for Oil-Spill-Contingency Response, Bird and Marine Mammal Protection, Sensitive Areas to be Considered in Oil-Spill-Contingency Plans, Coastal Zone Management, and the stipulations on Density Restriction Related to Commercial Fishing Uses, and Minimizing Potential Conflicts Between Oil and Gas Industry and Fishing Activities—provide additional mechanisms to ensure that activities that may follow this sale avoid conflict with the ACMP.

Conclusion: Potential conflict with the Statewide standard on habitats is possible. Site-specific information is necessary to ensure there is no conflict with the policies related to coastal development; geophysical hazards; energy-facility siting; transportation and utilities; subsistence; air, land, and water quality; and historic, prehistoric, and archaeological resources. Conflict is not inherent in the scenario.

(b) **Other Discharges:** In addition to the drilling muds and cuttings, there are a variety of other permitted discharges associated with exploration drilling that may be released into the waters of CI/SS. The types and volume ranges of the discharges for exploration wells drilled in other Alaskan OCS planning areas are shown in Table IV.B 1.a-3. Many of these discharges also are associated with production operations and the types and amounts of additives in the discharges associated with exploration drilling operations are assumed to be similar to the production-related discharges. The types of compounds and the amounts that might be used in drilling related discharges are shown in Table I.B.1.a-3. The types and amounts of compounds used will vary with each operation, and the information shown in the table is presented as possible examples. Dispersion in the receiving waters would further decrease the concentration of any additives. Seawater is the principal component of most of the discharges—in some cases it is the only constituent.

Sanitary and domestic wastes are monitored in accordance with the NPDES permit. Sanitary wastes mean human body waste discharged from toilets and urinals; domestic wastes includes wastes from showers, sinks, galleys, and laundries (USEPA, 1986). Sanitary and domestic wastes could range from 3,000 to 6,000 gpd and 4,000 to 7,000 gpd, respectively (Table IV.B.1.a-2). Any facility using a marine-sanitation device that complies with pollution-control standards and regulations under Section 312 of the Federal Water Pollution Control Act, as amended, shall be deemed to be in compliance with the discharge limitations of the NPDES permit (USEPA, 1986).

The discharge of drilling muds and cuttings and other discharges associated with exploration drilling are not expected to have any effect on the overall quality of the Cook Inlet water. Within a distance of between 100 and 200 m from the discharge point, the turbidity caused by SPM in the discharged muds and cuttings is expected to be diluted to levels that are less than the chronic criteria (100-1,000 mg/l) and within the range associated with the variability of naturally occurring SPM concentrations. Mixing in the water column would reduce the toxicity of the drilling muds which, in general, are practically nontoxic, to levels that would not be harmful to organisms in the water column. In general, the amounts of additives in the other discharges are expected to be relatively small (from 1 to 100 or 200 g/month) and diluted with seawater several hundred to several thousand time before being discharged into the receiving waters.

Conclusion: The overall quality of Cook Inlet water would not be affected by this alternative and would remain good (unpolluted).

b. **Effects on Lower Trophic-Level Organisms:** In the low case, exploration only is assumed in the sale area. There are no production activities associated with this alternative. Routine activities that may affect lower trophic-level organisms include seismic surveys and drilling discharges. The effects of these activities on lower trophic-level organisms are discussed in the base-case analysis in Section IV.B.1.b. The following low-case analysis focuses on the differences in the amount of activity (the only variable) estimated for the low case as compared to that of the base case. It then estimates the resulting effect of this difference on lower trophic-level organisms for the low case.

(1) **Effects of Seismic Surveys:** As discussed in the base-case analysis, seismic surveys are expected to have little or no effect on lower trophic-level organisms. The base case estimated that 11 seismic surveys would be required for three exploration wells, five delineation wells, and three production platforms. Because the low case involves only three seismic surveys, it is expected to have even less of an effect on lower trophic-level organisms. Hence, the low case is expected to have even less of an effect on lower trophic-level organisms than the base case (i.e., little or no effect).

(2) **Effects of Drilling Discharges:** The Exploration and Development Schedule (EDS) estimates a total of 3 exploration, 5 delineation, and 48 production wells for the base case. This would release about 2,880 short tons of drilling muds and 3,520 short tons of drill cuttings in the exploratory phase and another 17,760 short tons of drilling muds and 26,880 short tons of drill cuttings in the production phase into marine waters. Discharges of this type were found to have no adverse effects on planktonic organisms and mostly sublethal effects on benthic organisms. Any effect on benthic organisms would be limited to areas near and downcurrent of the discharge point. Less than 1 percent of the benthic organisms within the sale area would be affected by discharges associated with the base case, and recovery is expected within 1 year. Because the EDS for the low case estimates only three exploration wells (about 5% of the amount of discharges estimated for the base case), the low case is expected to have even less of an effect on lower trophic-level organisms than the base case.

(b) **Noise and Disturbance Effects from Exploration-Construction Activities:** For the low-case exploratory drilling, only one drilling unit is expected to be used each year at one time. Platform-installation activities associated with exploration temporarily could displace (one season) several birds near (within about 1 mi) the platform-installation site. Some brief (perhaps a few minutes to < 1 hour) displacement of birds could occur because of noise and movement of aircraft traffic (30-60 helicopter flights/month) between the Kenai/Nikiski area and the drill platform in lower Cook Inlet area and due to boat traffic (15-30 supply boats/month) between the drill platform and a marine-support facility in the Kenai/Nikiski area. These effects are expected to be local (within about 1 mi of the air- and boat-traffic routes), and disturbance of birds along these traffic routes is expected to be short term (a few minutes to < 1 hour for aircraft and boat disturbance of birds and one season or about 3 months within < 1 mi of the platform site during installation activities).

The analysis assumes that the oil industry and its contractors would comply with the ITL on Bird and Mammal Protection and avoid flying within 1 mi of seabird colonies and known bird-concentration areas. This compliance is expected to prevent excessive or frequent disturbance of seabird colonies and waterfowl and shorebird nesting and feeding concentrations.

On some occasions when weather and visibility are poor, support-helicopter flights and marine-vessel trips are expected to unavoidably disturb some (perhaps a few hundred to a few thousand) seabirds, waterfowl, and shorebirds. This would result in the temporary displacement (a few minutes to < 1 hour) of seabirds at a colony site or on the water or waterfowl and shorebirds on the water or on a coastal habitat. Any possible losses of young birds or eggs (perhaps ≤ 100) and reduced survival of some adult birds is expected to be short term, with recovery occurring within one generation

Conclusion: The overall effect on marine and coastal birds is expected to include the loss of very small numbers of birds or their eggs (such as ≤ 100 individuals), with recovery occurring within less than one generation, and no population effects on marine and coastal birds are expected to occur.

e. **Effects on Nonendangered Marine Mammals (Pinnipeds, Cetaceans, and the Sea Otter):** Nine species of nonendangered marine mammals commonly occur in the lower Cook Inlet sale area (see Sec. III.5). All marine mammals are protected species under the MMPA, as amended. The primary factors that may have deleterious effects on marine mammals in the sale area under the low case are noise and other disturbance associated with exploration (seismic activities and marine and aircraft traffic) and habitat loss and/or alteration. This analysis considers the potential effects of these factors under the low case on individual pinnipeds, cetaceans, and sea otters.

The Alternative I low case assumes no oil spills or direct oil contact on marine mammals. Under the low case, oil reserves are considered too low to be produced. Therefore, the low case is for exploration only.

Marine and logistics support would be from the Kenai/Nikiski area with air support from the Kenai/Nikiski area or Homer.

(1) **Effects of Noise and Disturbance on Marine Mammals:** Noise and disturbance activities that may affect marine mammals in the proposed sale area include geophysical surveys, marine dredging and construction, support vessels, aircraft overflights, and offshore drilling and production. Marine mammal population vulnerability to disturbance depends on several factors, including (1) the number of animals involved, (2) sensitivity of the species, (3) the presence of preferred habitat in relation to the disturbance, and (4) the characteristics of the disturbance source. The loudest noise source created by industry activity was identified as seismic noise. Sounds generated by seismic surveys are below the "most sensitive range" for pinnipeds and probably would not affect harbor and fur seal activities. Sea otters indicated no reaction to seismic noise from either a full array or single airgun. Effects on the minke whale have not been studied but likely would be similar to effects on other baleen whales. Baleen whales generally are tolerant of seismic pulses. Subtle behavioral changes may occur on occasion at low-sound levels, with stronger avoidance reactions when sound levels reach 160-170 dB, or higher. Toothed-whale hearing appears poor at frequencies lower than 1 kHz, where most industrial sounds and seismic pulses are produced

Aircraft overflights can be another potential source of disturbance. Pinniped response to low-altitude aircraft can result in stampede or flight into the water. This may increase pup mortality during the pupping season. Both summer periods, much less than 1 percent of their Pacific populations are expected to be exposed to disturbance and exhibit temporary adverse reactions; individual whales are expected to be affected for an hour or less per exposure incident. Given the rapid dilution of muds and cuttings that would occur, exposure of these whales to contaminants at detectable concentrations is not expected. Overall effect of exploration-phase exposure of sei, blue, right, or sperm whales to disturbance and contaminants is expected to be minimal.

(4) **Effects on the Steller Sea Lion**: Because potential sources of Steller sea lion disturbance are likely to be localized in a small portion of the proposed sale area, <2 percent of the Gulf of Alaska population is expected to be exposed to disturbance; individual sea lions are expected to be affected for a few minutes to tens of minutes per exposure incident. Because sources of disturbance are likely to be distant from rookeries, pup mortality from adult trampling is not expected to occur. Given the rapid dilution of muds and cuttings that would occur, exposure of sea lions to contaminants at detectable concentrations is not expected. Overall effect of exploration-phase exposure of Steller sea lions to disturbance and contaminants is expected to be minimal.

(5) **Effects on the Short-Tailed Albatross**: Because potential sources of short-tailed albatross disturbance and ingestible floating materials are likely to be localized in a small proportion of the proposed Sale 149 area, and this species is of extremely rare occurrence in the vicinity of the area, 0.2 percent of the population or less potentially could be exposed to disturbance and floating materials and exhibit adverse effects for a few minutes to tens of minutes per exposure incident. Given the small quantities of potential contaminants likely to be released, the rapid dilution that would occur following any small spill, and the expected rarity of this species' occurrence in the area, exposure of a short-tailed albatross to spilled contaminants at detectable concentrations is not expected to occur. Overall effect of exploration-phase exposure of the short-tailed albatross to disturbance, debris, and contaminants is expected to be minimal or none.

(6) **Effects on the Aleutian Canada Goose**: Because proposed Sale 149 exploration activities would be far removed from areas of known Aleutian Canada goose occurrence, this species is not expected to experience adverse effects.

(7) **Effects on the Steller's Eider**: Wintering Steller's eiders occupy coastal habitats mainly west and south of the proposed sale area and so are not expected to be affected by exploration activities.

(8) **Effects on the Peregrine Falcon**: Because potential sources of peregrine falcon disturbance are likely to be localized in a small portion of the proposed Sale 149 area, and this species is of uncommon occurrence in the vicinity of the area, less than 3 percent of the population potentially could be exposed to disturbance and exhibit avoidance effects for a few minutes to tens of minutes per exposure incident. Overall effect of exploration-phase exposure of the peregrine falcon to disturbance is expected to be minimal.

Conclusion: Because potential sources of disturbance of the above species are likely to be localized in a small portion of the proposed sale area used only secondarily, if at all, by small numbers of the above species, generally <2 percent of their Pacific populations (for most whale and all bird species, much less) are expected to be exposed to disturbance and exhibit adverse effects. Given the rapid dilution of muds and cuttings that would occur, exposure of any of these species to contaminants at detectable concentrations is not expected. Overall effect of exploration-phase exposure of any of these species to disturbance and contaminants is expected to be minimal.

g. **Effects on Terrestrial Mammals**: The primary effects of the low-case exploration-only scenario on brown bears, river otters, Sitka black-tailed deer, and other terrestrial mammals are expected to come from noise and disturbance associated with air-support traffic and, to a lesser extent, marine-support-vessel traffic.

Effects of Noise and Disturbance: For Sale 149 exploratory drilling, only one drilling unit is expected to be used each year. Some brief displacement (perhaps a few minutes to <1 hour) of brown bears and other terrestrial mammals is expected to occur because of noise and movement of aircraft traffic (30-60 helicopter flights/month or 1-2/day) to and from the Kenai/Nikiski area and the exploration-drill platform assumed to be located in the lower Cook Inlet area, and from boat traffic (15-30 supply boats/month). Vessel traffic would only be a potential source of disturbance of terrestrial mammals near or within about 1 mi of the assumed marine-support facility at the Kenai/Nikiski area. These effects are expected to be local; within about 1 mi of that portion of the aircraft-traffic route that passes over land between the Kenai airport and the offshore-drill platform in lower Cook Inlet within term effects on subsistence resources should have limited effects on community subsistence-harvest patterns and should not cause measurable changes in the availability or accessibility of subsistence resources.

A limited level of support and logistic activities is estimated to take place from existing air and marine facilities on the Kenai Peninsula and, therefore, such use of these facilities should not measurably increase the levels of effects on subsistence resources and harvests. Supply-boat and helicopter trips between these facilities and the exploration rig could interfere with subsistence harvests as a result of disturbance, but such events should be localized and subject to mitigation if consistently encountered.

Conclusion: Effects on subsistence-harvest patterns in the low case are expected to be localized, of short-term duration, and not of such an extent to create measurable changes in the availability or accessibility of subsistence resources.

k. Effects on Sociocultural Systems: Section III.C.4 describes the sociocultural systems for those communities in Southcentral Alaska that could be affected by the proposed lease sale. The analysis that follows takes into account effects from planning processes; routine activities that may result from the sale, such as the introduction of industrial activities and changes in community population levels; and potential effects on subsistence-harvest patterns.

Effects on sociocultural systems begin with the prelease processes of announcing the proposed sale and carrying out the preparation of an EIS. This sometimes lengthy process would cause stress and anxiety among affected publics. The discussion under the base case (Sec. IV.B.1.k.) fully explores the types of impacts involved.

An exploration-only approach is used in the low case. Three exploratory wells are drilled from a single drilling platform, with the conclusion after a 2-year period of exploration that there are no economically producible hydrocarbon resources available. A limited level of support and logistic activities are estimated to take place during this time from existing air and marine facilities on the Kenai Peninsula. Table IV.B.10.k-1 shows a 2.3- to 2.7-percent increase in resident population during these exploratory years. There would be no change in the resident population of the Kenai Peninsula in other years as a result of the lease sale under this case.

The limited level of support and logistic activities estimated to take place from existing air and marine facilities on the Kenai Peninsula is not expected to measurably increase the levels of effects on subsistence resources and harvests from these facilities. Therefore, there should be little or no sociocultural effect from the effects of exploration activities on subsistence harvests.

Conclusion: Affected publics in one or more southern Kenai Peninsula communities would undergo increased individual, social, and institutional stress and disruption during the prelease planning process. Otherwise, little or no effects on sociocultural systems are expected in the low case.

l. Effects on Archaeological and Cultural Resources: The activities that would produce effects on archaeological and cultural resources are exploration activities, marine- and logistics-support activities, and air-support activities from a support base on the western side of the Kenai Peninsula (see Sec. II.A.1).

The largest effects would come from vandalism, because more people would know about the location and would be present at the sites. That knowledge would increase as the population and activities increase. A second type of effect, resulting directly from cleanup work, would not be applicable if no oil were found, which is the scenario for the low case. The effects on environmental resources in the Cook Inlet sale area would be similar in type to those of base case exploration activities. There are potentially two shipwrecks (the *S. No. 2* and the *Flying Scud*) in the offshore lease area, and there are over 250 known onshore archaeological resources. Leasing activities may affect onshore resources, even if no oil were found. Prehistoric archaeological sites may be lost through looting, and indiscriminate or accidental activity on known and currently unknown sites. State archaeological analysis (AHRF, 1993) has shown that prehistoric and historic archaeological resources exist within the onshore area that could be disturbed, resulting in some loss of data.

Conclusion: The effects of the low case would be due to exploration activities and indiscriminate contact with archaeological sites from exploration personnel. The effects of the low case of the proposal on archaeological and cultural resources is estimated to be ≤1 percent of the archaeological sites and cultural resources.

m. Effects on National and State Parks and Related Recreational Places: In the national and State parks and related recreational places, resources are abundant and of high quality (see Sec. III.C.6). Drilling rigs and platforms can directly affect public perceptions of coastal and nearshore seascape views. Indirectly, rigs, platforms, and transportation vessels are associated with oil spills and marine trash and debris, which also can adversely affect the aesthetics of the marine environment or coastal shore.

For the Alternative I low case, only one platform would be used for exploration. However, platforms easily can be seen by passengers on planes flying over them. Set against the background of mountains and volcanoes, some of the platforms or their replacements have been in view for over 15 years, since drilling started in the area. The one new offshore rig and platform 10 or more miles out from shore may be barely perceptible from shore in the fairest of weather conditions, and it would be indistinguishable from objects such as ships or tankers and unlikely to spoil natural shorefront vistas. Platforms within 12 mi, however, would be a part of the viewing environment, and all platforms would be a part of the viewing environment of passengers on planes flying near them. For example, there are approximately 20 air flights per day between Anchorage and cities of the Kenai Peninsula on common carriers. Private aircraft make numerous special flights. Some tourism operatives have "flightseeing" trips over glaciers and volcanoes in the area. New platforms, rigs, or flares would have some effect on the view because they change the viewscape. Visitor rates would be reduced minimally. A decline in spending by visitors would be in proportion to the decline in the number of visitors.

Conclusion: Effects on parks and related recreational places would be from activities of exploration personnel and other indirect increases in population brought on by exploration activities. Effects on Alaska Peninsula resources could be from additional population pressure on recreational and tourism facilities. Effects of this alternative could reduce visual qualities of the parks and related recreational places from long distances very slightly and reduce visitor rates to those parks and related recreational places minimally. A decline in spending by visitors would be in proportion to the decline in the number of visitors.

n. Effects on Air Quality: Air-quality regulations and procedures are discussed in Section IV.B.1.n, the base case. That discussion also describes the methodology used to model the air-quality effects associated with this proposed lease sale. The USEPA-approved OCD model was used to calculate the effects of pollutant emissions from the proposal on onshore air quality. Because the Class I PSD areas allow for the least amount of degradation, the modeling scenario (i.e., source location) chosen for this analysis is the one that results in the maximum-potential effect to the air quality of the designated national wilderness area of the Tuxedni National Wildlife Refuge, the only Class I area adjacent to the proposed sale area. The maximum-potential effect at any location in the Class II area would be the same. In all likelihood, effects to the Tuxedni National Wilderness Area would be lower than those calculated by the model.

Under the low case, there would be exploration only with no oil development. Emissions from the peak-exploration year would be the same as for the base case. Table IV.B.1.n-1 lists estimated uncontrolled-pollutant emissions for the peak-exploration years. Under the Federal and State of Alaska PSD regulations, a PSD review would not be required. However, a permit still would be required, and the source would have to meet any applicable performance requirements set by the State of Alaska. The OCD model air-quality analysis for air pollutants emitted for exploration under the low case estimated that the maximum NO_2 concentration, averaged over a year, would be 0.19 μ/m^3 at the shoreline—7.6 percent of the available Class I increment for NO_2 and .76 percent for Class II. (Other pollutants also were modeled; however, NO_2 had the highest concentrations, which were well within PSD increments and air-quality standards.)

Air-pollutant levels reaching the shore are expected to be very low spatially and temporally because of the small amount of emissions from exploration activities and their distance from shore. In addition, there is no development or production under the low case to serve as a source of evaporation or smoke from oil spills. Consequently, the effects of air-pollutant emissions in the low case—other than with respect to standards—are expected to be minimal.

Conclusion: Assuming exploration only in the low case, effects on onshore air quality analyzed are expected to be 7.6 percent (approximately a third of those assessed for the Alternative I base case) of the maximum allowable PSD Class I increments. Only the Tuxedni National Wilderness Area is designated Class I, with the remaining area in and adjacent to the sale area designated Class II. Therefore, the potential effects would be much less. These effects would not make the concentrations of criteria pollutants in the onshore ambient air approach the air-quality standards. Consequently, a minimal effect on air quality with respect to standards is expected. Principally because

11. Alternative I, The Proposal, High Case:

Description of the Proposal: The high case of Alternative I (the proposed action) would offer for lease those parts of the Cook Inlet Planning Area identified in Figure II.A.1. The Alternative I area consists of approximately 403 whole and partial blocks encompassing approximately 1.9 million acres. The area of the proposed action is located between about 3 and 25 mi offshore in water depths that range from 1 ft to approximately 650 ft.

Activities Associated with the Proposal, High-Case Activities:

Resource Estimates and Basic Exploration, Development, and Production Transportation Assumptions for Effects Assessment:

High-Case-Resource Estimates: For the high case, it is assumed that 800 MMbbl of oil will be leased, discovered, developed, and produced in the Sale 149 area. A discussion of the resource range forecast for the high case of the proposed action is found in Section II.A. For the purposes of effects analysis within this section of this EIS, 800 MMbbl was selected as a representative resource level given the high-case resource range. Table IV.A-2 shows the levels of infrastructure and resources that were assumed for the analysis of the effects of the high case of the proposed action in Section IV. Although the development of natural gas resources is not considered economic for this proposed sale, the effects of any theoretical natural gas discovery is discussed in Section IV.F.

Timing of Activities: The level of activities and the timing of events associated with the high case for Alternative I are shown in Table IV.A.2. Table IV.A.2 also shows the infrastructure and development activities based on the assumed resource estimate of 800 MMbbl. Exploratory drilling is expected to begin in 1997 and continue through 1999. A total of 28 exploration and delineation wells are assumed to be drilled between 1997 and 1999. Installation of the first of the 11 production platforms is expected to occur in 1999 and continue over the following 5 years; pipeline laying is expected to begin in 2001 and end in 2002, with 150 mi of pipe laid. Drilling of production and service wells is expected to begin in 2000 and continue through 2005, with a total of 198 wells drilled. Production is expected to begin in 2003 and continue through 2021, with production peaking between the second and sixth year of the field. These calculations are based on an average drilling season, which potentially could be year-round in the lower Cook Inlet; however, unusually heavy winter ice, storms, and various environmental regulations could affect this hypothetical drilling schedule.

Activities Associated with Exploration Drilling:

Seismic Activity: In support of the proposed exploration and production activities, the lessee/operator is required to conduct surveys of sufficient detail to define shallow hazards or the absence thereof; these surveys should incorporate seismic profiling. The projected level of seismic activity is based on the nature and extent of the surveys that may be required (NTL 89-2, Minimum Requirements, Shallow Hazards Survey) and the predicted number of wells drilled. Surveys of the exploration- and delineation-well sites would be conducted during the ice-free seasons of the years of the exploratory phase. For this EIS, it is assumed that each of the eight exploration wells would be covered by site-specific surveys. These surveys would cover an approximate area of 8.9 mi^2 for each well; the total area covered by seismic surveys could equal 249.2 mi^2 These surveys usually are conducted 1 year prior to drilling. Surveys would be done during ice-free periods (March through October). The average time needed to survey each site should range between 2 and 5 days, allowing for downtime for bad weather and equipment failure. It should be noted that NTL 89-2 allows some flexibility for waiving the seismic requirement if sufficient data are available that can "determine the presence or absence of sea floor and subsurface geological and man made hazards."

Exploration Drilling: Water depth will be a significant factor in selecting the appropriate drilling unit. In the lower Cook Inlet, most depths within the sale area can be found between 250 and 300 ft. Exploratory drilling throughout much of this area would be carried out by semisubmersible drilling units; however, in shallower waters—<300 ft—jackup rigs could be used. Exploration drilling in the southern part of the sale area may be conducted year-round from semisubmersible drilling units, but pack-ice conditions in the northern part may limit drilling to the period from about the first part of April to mid-November. Exploration-and delineation well-drilling depths should average 6,000 ft.

Support and Logistics Activities: Air- and marine-support activities are expected to be staged from the Kenai Peninsula. Support-vessel operations would be staged from the Rig Tenders Dock at Nikiski. Material storage and general logistics support would be facilitated by Kenai's existing oil-field-support infrastructure. This infrastructure, a network of private contractors, has developed over the last 20 years to serve onshore oil and gas production on the Kenai Peninsula and offshore production in the upper Cook Inlet. Air support for lower Cook Inlet drilling operations also would come from the Kenai/Nikiski area. A dedicated helipad at the Kenai airport could be used to transfer personnel to the drill site. Personnel arriving for transport to the drill site are expected initially to enter the Kenai area via commercial fixed-wing aircraft; however, early on in the developmental phase offshore workers are expected, for the most part, to be or become local residents.

Support-boat operations are expected to average between one and two a day per platform (or as needed), the frequency diminishing into the production period. Air operations may reach two a day per platform as an average and decline into the production phase. Additional support vessels and helicopters would be kept on contract in proximity to drill operations to provide emergency assistance, if required.

Activities Associated with Oil Transportation: Should recoverable quantities of hydrocarbons be located, construction of expanded oil and gas processing facilities and tanker docks could begin in the Nikiski area 5 years after the sale date; trunk-pipeline laying would begin and conclude 7 years after the sale date. Production is assumed to begin 8 years after the sale. In the case of lower Cook Inlet, produced crude would be transported via a 150-mi, subsea pipeline to the Nikiski petroleum complex. The subsea pipeline would not be buried; because of the turbid conditions of the Cook Inlet and the depth at which the pipeline would rest, the weighted pipe would become covered with silt or would be self-buried.

Support-boat operations are expected to average between one and two a day per platform (or as needed), the frequency diminishing into the production period. Air operations may reach two a day per platform as an average and decline into the production phase. Additional support vessels and helicopters will be kept on contract in proximity to drill operations to provide emergency assistance, if required.

At the Nikiski complex, existing oil-storage facilities would be expanded to accommodate the additional crude production. Currently, there are 130 acres adjacent to existing facilities available to industry for plant expansion. Assuming a peak annual production of 70 MMbbl, crude-oil tankerage from Nikiski to the west coast of the U.S. may average 81 trips per year presupposing the use of 100,000-DWT tankers (as opposed to the 45,000-DWT class that were used in the base case). Crude oil transported from Nikiski may be refined in the Puget Sound, the San Francisco-Oakland Bay area, or the vicinity of the Port of Los Angeles. Figures IV.B.1-1 and 2 indicate the routes of oil tankers to the west coast. Except when entering port, tanker routes usually are 100 to 200 mi offshore, although some industry sources indicate that the crude carriers may come within 80 mi of shore.

a. **Effects on Water Quality:** For Alternative I (high case), the activities associated with petroleum exploitation that are most likely to affect water quality in the CI/SS Sale 149 area are (1) the permitted discharges from exploration-drilling units and production platforms, (2) accidental oil spills, and (3) construction activities. The characteristics of the discharges, spills, and activities and their potential effects on water quality are described in Section IV.B.1.a and summarized in this section. As noted in Section III.5.e, the quality of lower Cook Inlet water generally is good.

The hydrodynamic processes in the Cook Inlet Planning Area suggest the water column generally is well mixed, and dilution would reduce the concentration of the substances in the discharges. Degradation processes also act to continuously reduce the concentrations of any substances deliberately or accidentally released into the environment.

The permitted discharges would add substances that may be foreign to or increase the concentration of constituents already present in the water column of CI/SS. Of the permitted discharges, drilling muds and cuttings and produced waters are the most significant discharges associated with offshore operations and have received the most attention. This analysis will consider (1) the SPM/turbidity chronic criterion (for the protection of marine life) to range from 100 to 1,000 mg/l (Sec. IV.B.1.a(1)(a)1)), (2) 15 μg/l to be the total hydrocarbon chronic criterion (for the protection of marine life) and 1,500 μg/l—a hundredfold higher level—to be the acute criterion (Sec. IV.B.1.a(1)(b)2)a)), and (3) 10 μg/l to be the TAH chronic criterion (for the protection of marine life) and 1,000 μg/l to be the acute criterion (Sec. IV.B.1.a(1) (b)2)a)). In general, the added substances may cause sublethal

Production is estimated to begin in 2003 and continue through 2021 and, during the 19-year production life of the platform, an estimated 800 MMbbl of oil would be produced. Total production would peak from 2004 through 2008, when 67 MMbbl of oil would be produced each year.

Operations associated with (1) the drilling of production and service wells and (2) oil production generate a variety of permitted discharges that include drilling muds and cuttings, produced waters, and various other discharges described in Section IV.B.1.a(1)(b); these discharges may be intermittent or continuous. The production discharges contain a variety of chemicals used to improve or restore production, prevent or inhibit the growth of bacteria, inhibit corrosion and the formation of scale, improve separation of oil from water, and to clean facilities. The rate of adding chemicals to the various operations that generate the discharges could range from < 1 to several hundred gallons per month.

1) **Drilling Muds and Cuttings:** During the drilling of production and service wells, the discharge of drilling muds and cuttings introduces, on a dry-weight basis, an estimated 80 to 370 tons of drilling-mud components and 560 tons of cuttings per well into the marine environment; the drilling of wells from the same platform involves the recycling of some of the drilling muds to drill subsequent wells, and the amount varies from well to well. The total dry-weight discharges from drilling 198 production and service wells are estimated to be between 15,840 and 73,260 tons of drilling-mud components and 110,880 tons of cuttings during a 5-year period. The drilling discharges are expected to take place over a 5- or 6-year period.

2) **Produced Waters:** The discharge of produced waters is an issue of significant concern because of the types and amounts of naturally occurring substances they may carry and the manmade substances that may be added. Produced waters constitute the largest source of substances discharged into the waters. The description of produced waters for the high case is based on the information in Section IV.B.1.a(1)(b).

Some of the characteristics of the produced waters that might be expected from Sale 149 are based on the characteristics of waters produced between April 1987 and April 1988 from the Cook Inlet platforms (CI Discharge Monitoring Study—Sec. IV.B.1.a(1)(b)). These characteristics are shown in Table III.A.5-13; measurements of the discharge were taken from the discharge streams prior to mixing with the receiving waters.

The toxicity of produced waters mainly is caused by hydrocarbons. On this basis, the analysis of the effects of produced water discharges focuses on nonvolatile hydrocarbons (USEPA oil and grease) and TAH, two of the characteristics measured in the CI Discharge Monitoring Study (Sec. IV.B.1.a(1)(b)) that can be related to water-quality criteria noted previously. Other characteristics of the produced waters discussed in Section IV.B.1.a.(1)(b)2)c) are based on those features that also can be related to water-quality criteria or compared to existing parameters in the water column. These characteristics include toxicity, pH, salinity, BOD, and zinc concentration. It is assumed other constituents in the produced waters or the constituents in other discharges generally will be affected in a manner similar to one of the constituents analyzed in this section. As noted with the discharge of drilling muds, the effects of mixing the discharged produced waters with the receiving waters are to dilute the concentrations of the substances in the discharge.

Following 1990, the ratio of the total amount of water produced to the total amount of oil produced from the Cook Inlet oil fields ranged from about 0.09 to 0.74 (Table IV.B.1.a-2). Based on these ratios, the amount of water produced as a consequence of producing 800 MMbbl of oil might range from about 72 to 592 MMbbl, or more.

The amount of nonvolatile hydrocarbons (USEPA oil and grease) that might be discharged with the produced waters into Cook Inlet during the estimated producing life (19 years) of the high-case production platform is estimated to range from 240 to 3,374 tons (about 69-1,077 lb/day) (Table IV.B.1.a-2). This estimate is based on the production platform discharging a total of 72 and 592 MMbbl of produced waters containing 19 to 36 mg/l hydrocarbons (Sec. IV.B.1.a(1)(b)2)). During peak production (67 MMbbl/year), the amount of hydrocarbons discharged in the produced waters might range from about 20 to 313 tons per year (110-1,714 lb/day); the amount is expected to be closer to the lower end of the range as peak production occurs early in the life of the field when the ratio of the volume of waters produced to the volume of oil produced usually is low.

within the range of salinities that are found in Cook Inlet. The discharge of metals, as indicated by zinc, generally would be less than the amounts streams and rivers discharge into Cook Inlet. Mixing in the water column would reduce the toxicities of the produced waters which, in general, may range from slightly toxic to practically nontoxic prior to discharge.

(2) **Oil Spills:** Accidental oil spills associated with the exploration and production of oil may occur in lower Cook Inlet as a result of Sale 149. Based on OCS production-spill data, the production of 800 MMbbl of oil will result in an estimated 198 small spills (≤1,000 bbl) that would release an estimated 2,242 bbl (Tables IV.A.2-4a, b, and c) of oil into the water and an assumed large (≥1,000 bbl) spill of 50,000 bbl (Table IV.A.2-2). The factors affecting oil in the marine environment are discussed in Section IV.A.

The assumptions used to estimate concentrations are discussed in Section IV.B.1.a(2)(b) and summarized in the following paragraph. For the depth-of-mixing estimates, it is assumed the oil will be dispersed uniformly into the water column to a depth equivalent to the tidal range, 5 m, after 3 days; during this time interval, the area affected by the spill will have experienced six tidal cycles. At the end of 10 days, the oil is assumed to have dispersed to a depth of 10 m; during this time there will have been about 20 tidal cycles and two to three changes in the meteorologic events that affect wind-driven waves and surface currents. At the end of 30 days, the oil is assumed to have dispersed to a depth of 30 m; during this time there will have been about 60 tidal cycles and 7 to 10 changes in the meteorologic events that affect wind-driven waves and surface currents. Oil spills are exposed to a variety of physical, chemical, and microbiological forces that combine to degrade and, eventually, remove them from the water column (Karrick, 1977). The fate of petroleum in seawater is summarized in Section IV.B.1.a(2)(a). Processes affecting degradation of oil or removal of oil from the water column are neglected.

(a) **Exploration:** During exploration it is estimated there will be three oil spills and the average size of the spill will be 9 bbl (Table IV.A.2-4a). For a 9-bbl spill at the end of 3 days, the concentration of dispersed oil is estimated to be 24 μg/l in waters about 5 m deep and covering 2.3 km^2. With time, the size of the discontinuous area and the depth of mixing increases and the concentration of the dispersed oil decreases. The estimated concentrations of dispersed oil after (1) 10 days is 4 μg/l in waters 10 m deep and covering 11 km^2, and (2) 30 days is 0.4 μg/l in waters 30 m deep and covering 45 km^2.

(b) **Development and Production:** For the high case, the average amounts of oil spilled in each of the (1) small spills (<1,000 bbl) and (2) large spill (≥1,000 bbl) are the same as analyzed for the base case in Section IV.B.1.a(2)(c) and (d), respectively; summaries of these analyses are included in this section in the analyses of spills less than and greater than or equal to 1,000 bbl. The number of small spills associated with development and production is estimated to total 195; the amount of oil spilled is estimated to total 2,215 bbl (Table IV.A.2-4b and c).

1) **Oil Spills Less Than 1,000 Barrels:** As shown in Table IV.A.2-4b and c, the size of oil spills <1,000 bbl may be categorized as spills of (1) >1 but <50 bbl and (2) ≥50 but <1,000 bbl. For spills <50 bbl, the number of spills for the high case is estimated to be 187, and the average size of the spill is estimated to be 5 bbl (Table IV.A.2-4b). For spills ≥50 bbl but <1,000 bbl, the number of spills is estimated to be 8, and the average size of these spills is estimated to be 160 bbl (Table IV.A.2-4c). The assumptions used to estimate the concentrations of dispersed oil in the water column are the same as those used for the base case where they are described in Section IV.B.1.a(2)(b) and summarized in Section IV.B.11.a(2)(1).

For a 5-bbl spill in the summer, the concentration of dispersed oil is estimated to be about (1) 20 μg/l in a mass of water 1.7 km^2 and 5 m deep at the end of 3 days, (2) 3 μg/l in a watermass 8.8 km^2 and 10 m deep after 10 days, and (3) 0.3 μg/l in a watermass 34 km^2 and 30 m deep after 30 days (Sec. IV.B.1.a(2)(b)).

The effects on water quality of "small" spills ≥50 bbl are represented by the 160-bbl spill; (Table IV.A.1-4c); the estimated amount of oil dispersed into the water column after 3, 10, and 30 days is 15, 30, and 39 percent, respectively. For a 160-bbl spill, the concentration of dispersed oil is estimated to be about (1) 61 μg/l in a watermass 11 km^2 and 5 m deep at the end of 3 days, (2) 14 μg/l in a watermass 48 km^2 and 10 m deep after 10 days, and (3) 1 μg/l in a watermass 199 km^2 and 30 m deep after 30 days (Sec. IV.B.1.a(2)(b)).

The estimates of the amount of dispersed oil in the water column indicate that the concentration of spilled oil, immediately after a spill, in a relatively small area, may exceed the State of Alaska total hydrocarbon chronic

The size of the 50,000-bbl-spill beginning after a period of time, as represented by either the 3- or 10-day interval and the proximity of land, portends that the shorelines of Shelikof Strait are at risk of being contacted by spilled oil. The chance of spilled oil contacting the shorelines are described in Section IV.A.2.a(5)(b)1) and the fate of oil on the shorelines is described in Section IV.A.3.e.

Summary of the Effects of a Large Oil Spill (≥1,000 bbl) on Cook Inlet Water Quality: A large oil spill (≥1,000 bbl), as represented in this analysis by a spill of 50,000 bbl of crude oil, would degrade the quality of Cook Inlet water for a period of about a month or longer in an area that might extend over several thousand square kilometers. If the spill occurs within a relatively short period of time, as measured in hours, the hydrocarbon concentration in the water column generally is expected to be less than the acute criterion (1,500 μg/l) within several days. However, the hydrocarbon concentration by remain greater than the chronic criterion (15 μg/l) for a month or more.

(3) **Construction Activities:** The construction activities that potentially could affect the water quality in Shelikof Strait would be associated with trenching, laying, and burying of a trunk pipeline used to transport oil from the production platform to the shore. As noted in Section II.A.4, the high case assumes a 150-mi pipeline will be used to transport oil from the production platform to an oil-storage and -terminal facility located on the western side of the Kenai Peninsula; the pipeline-laying operations are assumed to take about 7 to 9 months. The trenching and burial activities temporarily will disturb the sea- floor sediments and resuspend particulate matter in the vicinity of the operations. The SPM concentration in the waters of lower Cook Inlet range from about 1 to 50 mg/l and consists, in part, of particulate matter resuspended by tidal currents and wind-driven waves and currents. The concentration of resuspended particulate matter in the water column from pipeline trenching and burial operations probably will be greater than the natural SPM concentration downcurrent from the operations. However, the turbulence caused by the tidal and other currents in the strait will dilute the concentrations of the resuspended particulates; the ratios of dilution could range from 10,000:1 to 1,000,000:1 within 100 to 200 m downcurrent of the trenching and burial operations. Construction activities are not expected to have any degradational effects on Cook Inlet water quality.

Summary: The activities associated with petroleum exploitation that are most likely to affect water quality for the Alternative I high case are (1) the permitted discharges from exploration-drilling units and production platforms, (2) oil spills, and (3) construction activities. The USEPA guidelines for issuing discharge permits require a determination that the permitted discharges will not cause unreasonable degradation of the marine environment. The hydrodynamic processes in the Cook Inlet Planning Area suggest the water column generally is well mixed, and dilution would reduce the concentration of the substances in the discharges. Degradation processes also act to continuously reduce the concentrations of many substances deliberately or accidentally released into the environment.

Of the permitted discharges, drilling muds and cuttings and produced waters are the most significant discharges associated with offshore operations. The permitted discharges would add substances that may be foreign to or increase the concentration of constituents already present in the water column of CI/SS. In general, the added substances may cause sublethal effects in some marine organisms if concentrations are greater than the chronic criteria (for the protection of marine life) and lethal effects if concentrations are greater than the acute criteria.

Drilling of the 28 exploration and delineation and 198 production and service wells could result in the discharge of an estimated 25,920 to 83,340 tons (dry weight) of drilling-mud components and 123,100 tons (dry weight) of cuttings. The concentrations of discharged drilling muds initially may range from about 1,000 to 2,000 g/l and are expected to be greater than the SPM/turbidity chronic criteria, 100 to 1,000 mg/l, assumed for this analysis. However, within about 100 to 200 m of the discharge point, mixing in the water column would reduce the concentrations by a factor of 10,000 to 1,000,000; the diluted concentrations are estimated to range from 1 to 200 mg/l. The concentration of SPM in lower Cook Inlet and Shelikof Strait ranges from about 1 to 50 mg/l. The toxicity of the drilling muds generally is low and the concentrations of the bulk constituents becomes nontoxic at the dilutions reached shortly after discharge. Most of the solids in the discharges settle rapidly to the seafloor, where bottom currents disperse the finer particles. The drilling discharges are expected to take place over a 5- or 6-year period—most of the discharges would occur in the last 3 years and be associated with the drilling of the production and service wells.

The discharge of drilling muds and cuttings is not expected to degrade the overall quality of Cook Inlet water.

There is about a 72-percent chance that a spill ≥1,000 bbl would occur but if it did, the size of the spill is estimated to be about 50,000 bbl. In the summer at the end of 3 days assuming no cleanup, the oil from a large spill may be dispersed in a 190 km^2 area in concentrations of about 711 μg/l. The concentration of the dispersed oil 10 days after a spill is estimated to be about 163 μg/l in an area of about 912 km^2 and after 30 days 21 μg/l in an area of about 3,714 km^2. For a summer spill, the concentration of total hydrocarbons in the water column from a large spill is not expected to exceed the acute criterion (1,500 μg/l), at least after 3 days, but may exceed the chronic criterion (15 μg/l for >30 days)

If the spill occurred in the winter, the size of the affected areas after the 3-, 10-, and 30-day-time intervals would be less than for a summer spill, but the concentration of oil in the water column would be greater. The oil in the water column is not expected to exceed the total hydrocarbon acute criterion (1,500 μg/l) during the (1) 3- to 30-day interval following a large spill under open-water conditions and (2) 10- to 30-day interval after a large spill in broken ice. During the 3- to 10-day interval following a large spill the oil in the water column is expected to exceed the total hydrocarbon acute criterion (1,500 μg/l) under broken ice conditions. The concentration of total hydrocarbons in the water column during the winter may exceed the acute criterion (15 μg/l for >30 days).

A large oil spill (≥1,000 bbl) would degrade the quality of Cook Inlet water for a period of about a month or longer in an expanding area that might extend over several thousand square kilometers for about a month, or more.

Construction activities would increase the turbidity in the water column along segments of a 150-mi corridor for about 5 months, but there would be no overall water quality degradation.

Conclusion: The permitted, routine discharges associated with oil and gas development and small (<1,000-bbl) oil spills are not expected to cause any measurable overall degradation of Cook Inlet water quality. Water quality would be reduced from good (unpolluted) to polluted by the presence of hydrocarbons from one or more large (≥1,000-bbl) oil spills that have a 72-percent chance of occurring. Contamination (the presence of hydrocarbons in amounts >15 μg/l) would be temporary (last for a month, or more) and affect an area of several thousand square kilometers.

b. Effects on Lower Trophic-Level Organisms: In the high case, both exploration and production are assumed to occur in the sale area. Routine activities associated with the high case that may affect lower trophic-level organisms include seismic surveys, drilling discharges, and dredging or construction. Accidental activities include exposure to petroleum-based hydrocarbons from an oil spill. The effects of routine and accidental activities on lower trophic-level organisms are discussed in the base-case analysis (Sec. IV.B.1.b) and are summarized below. The following high-case analysis focuses on the differences in the amount of activity (the only variable) estimated for the high case, as compared to that of the base case. It then estimates the resulting effect of this difference on lower trophic-level organisms for the high case.

(1) Effects of Seismic Surveys: For the high case, an estimated 39 seismic surveys would be required for the 11 exploration wells, 17 delineation wells, and 11 production platforms. However, as discussed in the base-case analysis, seismic surveys are expected to have little or no effect on lower trophic-level organisms. Thus, the high case is expected to have a similar effect on lower trophic-level organisms as that of the base case (i.e., little or no effect)

(2) Effects of Drilling Discharges: The EDS estimates a total of 3 exploration, 5 delineation, and 48 production wells for the base case. This would release about 2,880 short tons of drilling muds and 3,520 short tons of drill cuttings in the exploratory phase, and another 17,760 short tons of drilling muds and 26,880 short tons of drill cuttings in the production phase into marine waters. Discharges of this type were found to have no adverse effects on planktonic organisms and mostly sublethal effects on benthic organisms. Any effect on benthic organisms would be limited to areas near and downcurrent of the discharge point. It is estimated that <1 percent of the benthic organisms within the sale area would be affected by discharges associated with the base case, and recovery is expected within 1 year. Because the EDS for the high case estimates more drilling activity (198 wells) than for the base case (48 wells), the high case is expected to have about four times the effect on lower trophic-level organisms as that of the base case. Nevertheless, these effects would be mostly sublethal and still would affect <1 percent of benthic organisms in the sale area.

communities is expected to take 2 to 3 years in high-energy habitats and up to 7 years in lower energy habitats. Small oil spills (estimated total of 2,242 bbl) may adversely affect individual lower trophic-level organisms in small areas immediately around the spills. However, they are not expected to have perceptible effects on lower trophic-level organisms at the population level.

Conclusion: The assumed high-case oil spill is estimated to have sublethal and lethal effects on 1 to 5 percent of the plankton and 40 to 60 percent of the intertidal and shallow subtidal marine plants and invertebrates in the sale area. Less than 5 percent of the subtidal benthic populations in the sale area are expected to be affected. Recovery is expected to take up to 2 weeks for plankton. The recovery of marine plants and invertebrates is expected to take 2 to 3 years in high-energy habitats and up to 7 years in lower energy habitats. All of the above effects are based on the assumptions discussed in the text (e.g., the 50,000-bbl-oil spill occurs, and land segments having a probability of occurrence and contact ≥1% are contacted).

c. **Effects on Fisheries Resources:** The primary factors that may have deleterious effects on fisheries resources in the sale area under the high case are oil spills, noise and other disturbances associated with exploration and development (e.g., seismic activities, marine and aircraft traffic), and habitat loss and/or alteration. This analysis considers the potential effects of these factors on individual fish species, including the effects of the EVOS. During the course of this project, one large oil spill ≥1,000 and 198 smaller oil spills of 1 to 999 bbl are assumed to occur. For the purposes of analysis, this EIS assumes one 50,000-bbl spill will occur (Table IV.A.2-2).

To help estimate the potential effects of an oil spill for proposed Sale 149, an OSRA was performed for the lower Cook Inlet area. (Readers interested in more detail on the model and the assumptions used are directed to Sec. IV.A.2.a.) The following section describes the potential effects of oil contact to fisheries resources in the sale area using the OSRA-model results.

Combined Probabilities: The combined probabilities estimate the probability of a spill occurring from all sources (transportation or platform) and contacting environmental resource areas, land segments, or sea segments during the 19-year life of the proposal at intervals of 3, 10, and 30 days. The names and locations of environmental resource areas and land and sea segments referred to throughout this section are listed in Table IV.A.2-1.

The chance of one or more ≥1,000-bbl-oil spills occurring (27% base case vs. 72% high case) and the combined probability (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting various environmental resource areas is higher for the high case than the base case. But the chance of occurrence and contact to various environmental resource areas still is relatively low. This is best illustrated by an examination of the highest combined probabilities. After 3 days, the combined probabilities (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting Tuxedni Bay (ERA 1) and Kamishak Bay (ERA 4) is 22 percent. The combined probability (expressed as percent chance) is 5 percent for the Portlock Bank (ERA 25) and sea segment 1, 6 percent for the Barren Islands (ERA 6), 7 percent for Chinitna Bay (ERA 2), 9 percent for inner Kamishak Bay (ERA 5), 10 percent for Cape Douglas (ERA 7), 11 percent for Kachemak Bay (ERA 3), and 15 percent for sea segment 2. After 10 days, the combined probability (expressed as percent chance) increases to 28 percent for outer Kamishak Bay and to 25 percent for Tuxedni Bay (ERA 1). Similar 1- to 2-percent increases occur for the other previously mentioned environmental resource areas, with the addition of Hallo/Kukak Bays (ERA 9) at 5 percent. After 30 days, the combined probability (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting Tuxedni Bay does not change, but outer Kamishak Bay increases to 29 percent. No increase or small (1%) increases occur for the other previously mentioned environmental resource areas. Finfish species from these resource areas potentially affected by oil spills are: (1) returning adult salmon (king, red, pink, chum, and silver), steelhead trout, and hooligan transiting lower Cook Inlet; (2) outmigrating juvenile salmon entering Cook Inlet from natal rivers and streams along western Cook Inlet and southeastern Cook Inlet including Kachemak Bay (ERA's 1 through 5, and sea segments 1 and 2), particularly intertidally spawned pink salmon eggs in Kachemak Bay and around the southern portion of the Kenai Peninsula; juvenile pollock and pelagic pollock eggs in the southern portion of lower Cook Inlet in the vicinity of Cape Douglas; and (3) demersal fishes (e.g. halibut, cod, and sablefish) in the potentially affected ERA's. For all other environmental resource areas and land segments, estimated combined probabilities (expressed as percent chance) of one or more spills ≥1,000 bbl occurring and contacting are <5 percent.

class spawned during the spill year and be masked to some extent by the contribution of other year-classes to the herring population. Eggs and larvae of some semidemersal and demersal fishes may suffer increased mortality from oil contact. Also, some demersal fish populations could be exposed to oil in the event of a spill, and a few individuals could be killed. Based on experience of the EVOS, however, it is unlikely there would be any population-level effects to demersal fishes.

Indirect effects such as ingesting oil from contaminated food could cause slower growth of pink salmon juveniles due to the metabolic cost of depurating the hydrocarbon burden. This may have cause an incremental reduction in survival to adulthood, but is not expected to have population-level effects.

Fisheries resources could be disturbed and displaced from the immediate vicinity of drilling discharges, within a radius probably not to exceed 100 m. These effects on demersal fishes very likely would be limited to only the short time periods of the discharge. Offshore construction also could temporarily disturb and/or displace fisheries resources. Any disturbance or displacement should be short term (hours to days), limited to only the time of construction and shortly thereafter. Though seismic-surveys may damage eggs and larvae of some fishes, this injury is limited to within a meter or two from the airgun-discharge ports. Thus, seismic surveys probably would have no appreciable adverse effects on fish populations.

Conclusion: An oil spill would have no appreciable adverse effects on adult pelagic fishes. Eggs and larvae of pink salmon and semidemersal and demersal fishes could suffer increased mortality. Such mortality is not expected to have a population-level effect on pink salmon but may cause a reduction in survival of an entire herring year-class. Some individual demersal fishes are expected to be killed by the spill, but this mortality is not expected to affect demersal fish populations. Fisheries resources are expected to be temporarily disturbed and displaced by drilling discharges and offshore construction. These disturbances should be short term (hours to days). Seismic surveys may damage some eggs and larvae, but the injury is not expected to cause population-level effects. The chance of one or more ≥1,000-bbl oil spills occurring (27% vs. 72% chance) and the combined probability (expressed as percent chance) of one or more ≥1,000 bbl spills occurring and contacting various environmental resource areas is higher for the high case than the base case. Overall, however, the effects on fisheries resources from the high case are not expected to be much different than those resulting from the base case.

d. Effects on Marine and Coastal Birds: The primary adverse effects on marine and coastal birds from high-case OCS exploration and development activities in the proposed sale area are expected to come from oil pollution of the marine environment. Lesser effects are expected to come from noise and disturbance of birds and alteration of habitats.

(1) Effects of Oil Spills: Under the high case, oil development is assumed to occur in the lower Cook Inlet area with about the same oil-transportation scenario (11 rather than 3 production platforms) with the oil transported by a 150-mi-subsea pipeline to a pipeline landfall at Nikiski on the Kenai Peninsula.

Attention is devoted to spills that have a trajectory period of up to 30 days during the summer season (April-September). The combined probability (expressed as percent chance) of one or more ≥1,000-bbl-oil spills occurring and contacting land in general increased from 26 percent under the base case to 70 percent under the high case. Under the high case, combined probabilities (expressed as percent chance) of one or more ≥1,000-bbl-oil spills occurring and contacting marine and coastal bird habitats would increase substantially over the combined probabilities for the base case (Fig. IV.B.11.d-1). A comparison between the high case and the base-case combined probabilities (expressed as percent chance) of one or more ≥1,000-bbl-oil spills occurring and contacting important habitats of marine and coastal birds is shown in Figure IV.B.11.d-1. The combined probabilities (expressed as percent chance) of one or more ≥1,000-bbl-oil spills occurring and contacting Tuxedni, Chinitna, Kamishak, and Kachemak Bays; Cape Douglas; Shuyak Island; Kukak Bay; Barren Islands; and Portlock Bank bird-habitat areas increased over that of the base case (Fig. IV.B.11.d-1; ERA's 1, 2, 4-5, 3, 6 7, 8, 9, and 25, respectively). The chance of one or more ≥1,000-bbl spills occurring and contacting south of the Kalgin Island area (pipeline to Nikiski) increased substantially (4-17%). The chance of one or more ≥1,000-bbl oil spills occurring and contacting habitats south of Shelikof Strait also increased slightly over that of the base case (SS's 2 and 3, respectively; Fig. IV.B.11.d-1).

Depending on the weather (winds and currents) in the spill area and spreading (over an area of 178-3,458 km^2 as a discontinuous oil slick from the assumed 50,000-bbl spill, Table IV.A.3-1), several thousand—to perhaps

100,000— birds are likely to be affected by the 50,000-bbl spill. Assuming a spill contaminated seabird habitat near the Barren Islands or on Portlock Bank where large concentrations of murres and other seabird species occur during the spring-summer season, several thousand birds are expected to be killed. If the oil spill contaminated the seabird-rafting area near the Barren Islands or in Tuxedni Bay just after the nesting season, several thousand adult murres and their young are expected to be killed.

Contamination of intertidal prey organisms along the Alaska Peninsula (Chinitna and Kamishak Bays) could affect productivity of local sea ducks and shorebirds that depend on these food sources, with effects lasting for >1 year after the spill. The contaminated intertidal invertebrates could decrease local productivity of waterfowl and shorebirds for >1 year. The direct loss of sea ducks due to the oil spill might range from a few thousand to perhaps tens of thousands or more. Local reduction or contamination of available food sources due to an oil spill also could reduce survival and reproductive rates of several thousand migratory waterfowl and shorebirds that use that habitat for that season and perhaps for a number of years after the spill, particularly if the oil remains trapped in coastal sediments of protected mudflats and saltmarshes.

A total of 187 small oil spills ≥1 and <50 bbl and 8 spills ≥50 bbl and <1,000 bbl also are estimated to occur under the high case (Table IV.A.2-4b and 4c). These minor spills are expected to have an additive effect on marine and coastal bird losses, perhaps increasing losses by a few thousand birds and increasing habitat contamination by perhaps 1 to 2 percent.

The effects of oil spills on marine and coastal birds under the high case are expected to be very similar to the spill effects under the base case, with full recovery expected to take more than one generation (probably <3 generations or about 15 years).

(2) Effects of Noise and Disturbance: Human activities associated with OCS exploration and development under the high case are expected to be very similar in magnitude and duration as those activities (air and vessel traffic) described under the base case.

Noise and Disturbance Effects from High-Case Exploration, Development, and Production Activities: For the Sale 149 high case, two exploration-drilling units are assumed to be used each year and 11 production platforms are assumed to be installed, which is a considerably higher level of activity than described under the base case (3 production platforms). Platform-installation activities associated with exploration and development are expected to temporarily displace (1 season) several birds near the platform-installation site. Some brief displacement (perhaps a few minutes to <1 hour) of birds could occur because of noise and movement of aircraft traffic (60-120 helicopter flights/month) between the Kenai/Nikiski area and the drill platforms in lower Cook Inlet area and due to boat traffic (30-60 supply boats/month) between the drill platforms and a marine-support facility in the Kenai/Nikiski area. These effects are expected to be local, within about 1 mi of the aircraft- and boat-traffic routes; and disturbance of birds along these traffic routes is expected to be short term, a few minutes to <1 hour for aircraft and boat disturbance of birds and one season or about 3 months for platform installation activities.

The analysis assumes that the oil industry and its contractors would comply with the ITL on Bird and Mammal Protection and avoid flying within 1 mi of seabird colonies and known bird-concentration areas. This compliance is expected to prevent excessive or frequent disturbance of seabird colonies and waterfowl-and shorebird-nesting and feeding-concentration areas.

(3) Effects of Habitat Alteration: Habitat-alteration effects on marine and coastal birds under the high case are expected to be about the same as under the base case, with local displacement (within 1 mi) near the 11 production platforms during installation and near the pipeline landfall at Nikiski. After installation, the platforms may act as temporary perch sites for some birds and may act as shelter sites on the water on the leeward side of the platforms during storms. This may expose these birds to accidental oil spills from the platforms. This alteration of habitat is expected to last over the life of the field but is not expected to have any population-level effects on marine and coastal birds in the lower Cook Inlet area.

Noise and disturbance from air- (60-120 flights/month) and marine-vessel (30-60 trips/month) traffic are expected to be local (within 1 mi of the traffic and platform) and short term (<1 hour for air- and vessel-traffic-disturbance events to <1 year for pipeline- and platform-construction activities). Local habitat alteration at the platform sites and the presence of 11 production platforms in lower Cook Inlet are expected to last over the life of the oil field but

(1993) believe the 1989 missing animals were killed by the spill, and mortality in the year following the spill was due to long-term effects suffered in the spill year, although there is no direct evidence to support their beliefs.

3) Sea Otters: Effects of the EVOS on the sea otters of Prince William Sound, the Kenai Peninsula, and the Kodiak Island/Alaska Peninsula were profound. Sea otters contaminated during the spill suffered from a variety of ailments, including interstitial pulmonary emphysema, gastric erosion/ulceration and hemorrhage, renal and hepatic lipidosis and necrosis, hypothermia, stress, and shock. Stress and shock also were resultant from capture and cleaning, in addition to oiling. All of the above effects contributed to sea otter mortality associated with the EVOS (Lipscomb et al., 1993).

The minimum estimate of sea otter acute mortality based on total number of carcasses was 904 after adjusting for the number of otters that died prespill but were recovered by spill-response teams. Extrapolation from an experiment on carcass-recovery rate estimated a total of 4,028 sea otter deaths resulted from the spill over the entire spill area and 2,209 for Prince William Sound (Doroff et al., 1993). Sea otter spill-related-acute mortality also was estimated by another method that compared ratios of animals counted in years prior to the spill to counts made after the spill. The number of sea otter deaths estimated from this method for Prince William Sound otters was 2,800, with a confidence interval of 500 to 5,000 otters (Garrott, Eberhardt, and Burn, 1993).

For a complete discussion of previous oil-spill effects on marine mammals, including the estimated effects from the EVOS on Prince William Sound harbor seals, killer whales, and sea otters, see Section IV.B.1.e.(1)(a).

(2) Sale-Specific Effects of Oil Spills: To help estimate the potential effects of an oil spill for proposed Sale 149, an OSRA was performed for the lower Cook Inlet area. Readers interested in more detail of the OSRA model and the assumptions used are directed to Section IV.A.2.a.

(a) Assumptions of the Probability Analysis: The estimated mean number of spills is 1.26, and this analysis assumes a single spill of 50,000 bbl (Table IV.A.2-2). A complete presentation of oil-spill statistics associated with this proposal are directed to IV.A.2.a.

1) Sale-Specific Effects: Sale-specific effects on marine mammals were estimated by using the combined probabilities and the conditional probabilities. Conditional probabilities were used by moving the location of the spill point along the oil-transportation corridors to the various resource areas most sensitive for each species. Mortality rates derived from the EVOS and adjusted by the Sale-Specific Mortality Factor (SF) were used to estimate potentially lethal effects of the various spill scenarios on each species, where possible. For details on the assumptions of the effects analysis, conditional probability analysis, and the SF, see Section IV.B.1.e.3.

2) Combined Probabilities: The combined probabilities estimate the probability of a spill occurring from all sources (transportation or platform) and contacting environmental resource areas, land segments, or sea segments during the 19-year life of the proposal at intervals of 3, 10, and 30 days. Names and locations of environmental resources and land and sea segments referred to throughout this section are listed in Table IV.A.1-1.

The combined probability of one or more oil spills ≥1,000-bbl occurring and contacting various environmental resource areas is higher for the high case than the base case but is still relatively low. This is best illustrated by an examination of the highest probabilities. After 3 days, the combined probabilities (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting Tuxedni Bay (ERA 1) and Kamishak Bay (ERA 4) is 22 percent. The combined probability (expressed as percent chance) is 5 percent for Portlock Bank (ERA 25) and SS 1, 6 percent for the Barren Islands (ERA 6), 7 percent for Chinitna Bay (ERA 2), 9 percent for inner Kamishak Bay (ERA 5), 10 percent for Cape Douglas (ERA 7), 11 percent for Kachemak Bay (ERA 3), and 15 percent for SS 2. After 10 days, the combined probability (expressed as percent chance) increases to 28 percent for outer Kamishak Bay and increases to 25 percent for Tuxedni Bay (ERA 1). Similar 1- to 2-percent increases occur for the other previously mentioned environmental resource areas, with the addition of Hallo/Kukak Bays (ERA 9) at 5 percent. After 30 days, the combined probability (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting Tuxedni Bay does not change, but outer Kamishak Bay increases to 29 percent. No increase or small (1%) increases occur for the other previously mentioned environmental resource areas. Marine mammal species from these environmental resource areas potentially affected by oil spills are: nonendangered mammal populations than the direct effects of oil ingestion described above (Sec. IV.B.1.e.1.c). For a complete discussion of the potential indirect effects of oil on marine mammals, see Section IV.B.1.e (base case).

(4) **Effects of Noise and Disturbance on Marine Mammals:** Noise and disturbance activities that may affect marine mammals in the proposed sale area include geophysical surveys, marine dredging and construction, support vessels, aircraft overflights, and offshore drilling and production. Marine mammal population vulnerability to disturbance depends on several factors, including (1) the number of animals involved, (2) sensitivity of the species, (3) the presence of preferred habitat in relation to the disturbance, and (4) the characteristics of the disturbance source.

The loudest noise source created by industry activity was identified as seismic noise and was expected to have minimal effects on nonendangered marine mammals. Overflight-disturbance reactions probably would be short term, with seals reoccupying haulouts and whales continuing their activities usually within a matter of hours. For a complete discussion of the potential effects of noise and disturbance on marine mammals, see Section IV.B.1.e (base case).

(5) **Effects of Habitat Loss and/or Alteration on Marine Mammals:** Habitat loss or alteration would be limited to temporary disturbance to some sea otters and harbor seals in the nearshore environment associated with construction of pipeline and transport facilities. Disturbance from habitat alteration/construction activities would be relatively short term and very localized and should not affect marine mammal survival. For a complete discussion of the potential effects of habitat loss and or alteration on marine mammals, see Section IV.B.1.e (base case).

(6) **Summary:** The basic differences between the high case and the base case are (1) the combined probability of occurrence and contact of oil to marine mammal resources and (2) the volume of oil assumed to be discovered and produced. Because the volume of oil discovered and produced is larger for the high case, the risk to resources is increased under the combined probabilities. For the high case, the probability of occurrence and contact on the western side of Cook Inlet is higher and probable extent of occurrence and contact is broader, extending from SS 1 and southward to the Hallo/Kukak Bay. On the eastern side, the probable extent of occurrence and contact extends from Kachemak Bay southwest toward to the Barren Islands.

Most marine mammal mortalities were about the same as the proposal under the high case. However, the area of probable contact determined by the combined probabilities was larger and affected larger concentrations of sea otters and harbor seals. Thus, estimated sea otter and harbor seal mortality increased to 336 and 151 individuals, respectively, above the mortality estimates for the base case.

There is no difference between the base and high cases in the conditional probability risk contours or the conditional probability analysis for the transportation segments that were used to determine potential effects on marine mammal species in the sale area. The conditional probability analysis considered greater potential effects to environmental resources than did the combined probabilities. However, the combined probability results present the most likely effects to marine mammals and are given greater weight in this analysis.

(7) **Mitigating Measures:** Marine mammal disturbance associated with exploration and development would be mitigated by the in-place mitigation measures—Stipulation No. 2, Protection of Biological Resources, and ITL's No. 1, Information on Bird and Marine Mammal Protection, and No. 2, Sensitive Areas to be Considered in the Oil Spill Contingency Plans. These mitigating measures are intended to preserve and protect biological resources from damage by industrial activities. They also make the lessee aware of protective legislation (such as the MMPA), specific wildlife-concentration areas, and prevent overflight of known seal haulouts, breeding areas, and aggregations of other marine mammal species.

Conclusion: Sale-specific oil-spill effects suggest Tuxedni Bay (ERA 1), Kamishak Bay (ERA 4), Portlock Bank (ERA 25), Barren Islands (ERA 6), Chinitna Bay (ERA 2), inner Kamishak Bay (ERA 5), Cape Douglas (ERA 7), Kachemak Bay (ERA 3), Hallo/Kukak Bays (ERA 9), and SS's 1 and 2 have the highest combined probability (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting during the life of the proposal, potentially affecting sea otters, harbor seals, pelagic fur seals, and nonendangered cetaceans; particularly beluga whales and killer whales. Estimated mortality for fur seals was 6 to 8 individuals, with no effect on the fur seal population. Harbor seal mortality was estimated at 151 individuals. This level of mortality was probably not less per exposure incident. Likewise, although the combined probability of one or more ≥1,000-bbl spills occurring and contacting specific environmental resource areas is three to four times greater under this scenario than the base case, few humpback whales potentially would be expected to be exposed in the proposed lease area or vicinity, with the result being temporary sublethal effects. No humpback whales are expected to be exposed to discharge concentrations beyond those that would result in minimal effects. Overall effect of exposure of humpback whales to disturbance is expected to be minimal, similar to the base case; given the small numbers of whales likely to be contacted by any oil spill, the effect is not expected to be significantly greater than for the base case, but is more likely to occur. No humpback whale mortality is expected to result from this lease sale.

(3) **Effects on Sei, Blue, Right, and Sperm Whales:** Because potential sources of sei, blue, right, and sperm whale disturbance are likely to be localized in a small portion of the proposed sale area, entered infrequently by small numbers of these whales during migration or summer periods, much < 1 percent of their Pacific populations is expected to be exposed to disturbance and exhibit temporary adverse reactions; individual whales are expected to be affected for an hour or less per exposure incident. Likewise, although the combined probability of one or more ≥1,000-bbl spills occurring and contacting specific environmental resource areas is three to four times greater under this scenario than for the base case, few whales potentially are expected to be exposed in the proposed lease area or vicinity, resulting in temporary sublethal effects. Given the small quantities of potential contaminants likely to be released, and/or the rapid dilution that would occur following any spill, exposure of these whales at detectable concentrations is not expected to occur. Overall effect of exposure of sei, blue, right, or sperm whales to disturbance is expected to be minimal, similar to the base case; given the small numbers of whales likely to be contacted by any oil spill, the effect is not expected to be significantly greater than for the base case, but is more likely to occur. No mortality of these species is expected to occur from this lease sale.

(4) **Effects on the Steller Sea Lion:** Because potential sources of Steller sea lion disturbance are likely to be localized in a small portion of the proposed sale area, < 2 percent of the Gulf of Alaska population is expected to be exposed to disturbance; individual sea lions are expected to be affected for a few minutes to tens of minutes per exposure incident. Because sources of disturbance are likely to be distant from rookeries, pup mortality from adult trampling is not expected to occur. Although the combined probability of one or more ≥1,000-bbl spills occurring and contacting specific environmental resource areas is three to four times greater under this scenario than for the base case, exposure of the Steller sea lion population occupying the proposed sale area and vicinity to an oil spill is expected to result in a loss < 100 individuals. Overall effect of Steller sea lion exposure to disturbance and minor contaminant spills is expected to be minimal, similar to the base case; given the relatively small numbers likely to be contacted by any oil spill, the effect is not expected to be significantly greater than for the base case, but is more likely to occur, requiring two generations or less for recovery.

(5) **Effects on the Short-Tailed Albatross:** An estimated ≤0.2 percent of the short-tailed albatross population potentially could be exposed to disturbance, exhibiting adverse effects for a few minutes to tens of minutes per exposure incident because potential sources of disturbance are likely to be localized in a small portion of the proposed Sale 149 area, and this species is of extremely rare occurrence in the vicinity of the area. Also, the expected rarity of albatrosses in this area suggests that digestible floating materials would be encountered rarely, and thus represent a hazard to only a minute fraction of the population. Likewise, this species' expected rare occurrence and the low probability of a substantial oil spill in the area suggest that exposure to a spill would not occur. Overall effect of exposure of the short-tailed albatross to disturbance, debris, and contaminants is expected to be minimal or none

(6) **Effects on the Aleutian Canada Goose:** Because potentially disturbing activities associated with this sale would be far removed from the Semidi Islands, Aleutian Canada geese are not expected to experience any effect from such activities. Likewise, because the probability of spilled oil reaching the Semidi Islands is low, and geese do not typically occupy habitats likely to be oiled, effect of any oil spill is expected to be minimal. Overall effects on the Aleutian Canada goose are expected to be minimal, affecting < 1 percent of the population.

(7) **Effects on the Steller's Eider:** Steller's eiders wintering in nearshore areas along the Alaska Peninsula to Kodiak Island and southern Cook Inlet are not expected to experience adverse effects from

to 72 percent from the 27 percent under the base case as a result of the increase in assumed oil resources from 200 MMbbl (base case) to 800 MMbbl (high case). However, one spill of 50,000 bbl, as under the base case, is assumed to occur for the high case.

Under the high case and the base case, the combined probabilities of one or more oil spills ≥ 1,000 bbl occurring and contacting terrestrial mammal habitats is shown in Figure IV.B.11.g-1. Combined probabilities (expressed as percent chance) of one or more ≥ 1,000 bbl oil spills occurring and contacting the Alaska Peninsula north from Cape Douglas to Kalgin Island increases substantially (such as from 2 to 6%, 2 to 8%, 2 to 9%, 2 to 7%, and 2 to 9% for LS's 22, 27, 30 and 32, and 35 respectively) compared to the base case (Fig. IV.B.11.d-1, LS's 22 through 35). The combined probabilities of one or more ≥ 1,000 bbl oil spills occurring and contacting shoreline habitats on the eastern side of lower Cook Inlet/Kenai Peninsula also increases under the high case (Fig. IV.B.11.g-1, LS's 38-46). Combined probabilities of one or more ≥ 1,000 bbl oil spills occurring and contacting the Alaska Peninsula from Kukak Bay north to Hallo Bay (LS's 18, 19, and 20) also would increase (<0.5 to 2%) over that of the base case (Fig. IV.B.11.g-1) and some chance of occurrence and contact (1%) to Afognak Island is estimated under the high case (Fig. IV.B.11.g-1; LS's 73-79). Thus, the chance of one or more oil spills ≥ 1,000 bbl occurring and contacting coastal habitats of river otters, brown bears, and other terrestrial mammals increases under the high case.

The assumed 50,000-bbl-oil spill is expected to be associated with the oil-tanker traffic from the terminal at Nikiski on the Kenai Peninsula through Cook Inlet and the Gulf of Alaska or associated with the offshore pipeline or platforms in the sale area. Such a spill might be from a fully loaded tanker colliding with a reef located in the Chugach Islands area, with the spilled oil contacting coastal habitats on the lower Kenai Peninsula and along the Alaska Peninsula.

A number of river otters (perhaps ≤50) are expected to be directly killed assuming the oil contacted the shoreline along the Kenai and Alaska Peninsulas. However, more river otters (≥100) that inhabit coastal habitats that become oiled are expected to ingest oiled mussels and other intertidal prey organisms, resulting in changes in habitat use and reduced diversity in food-source availability, which would lead to decreased body growth and fitness in coastal otters that are continually exposed to contaminated prey. These effects are expected to last > 1 year for otters inhabiting areas where food sources remain contaminated for years after the spill. However, the effects on river otters are expected to be local (within a portion of the estimated 140 km of oiled shoreline from the 50,000-bbl spill).

Brown bears inhabiting the Kenai and Alaska Peninsulas, such as in the Kachemak Bay area, Tuxedni-Chinitna Bays, and southward to Katmai coastline are expected to ingest oil-contaminated prey (such as mussels and clams) and carrion. Small numbers of bears (perhaps ≤ 10) are expected to be lost from contact with the oil spill (ingesting oil through grooming of oiled fur or ingesting heavily oiled prey). Assuming that an important brown area in either the Tuxedni Bay, Ursus Cove, or Chinitna Bay areas were heavily oiled from a spill, some portion of the brown bear population (perhaps ≥30 bears) that use this habitat during the summer are expected to ingest oiled clams from contaminated intertidal sediments. This ingestion is expected to have sublethal effects on the fitness of some bears and contribute to a decline in survival of exposed bears. However, neither these sublethal effects nor the direct loss of bears to the spill (perhaps 10 bears) are expected to have population-level effects on brown bears on the Alaska and Kenai Peninsulas.

Assuming the 50,000-bbl oil spill contacts winter habitat of Sitka black-tailed deer along the Shuyak-Afognak coastline (Fig. IV.B.9-g(1), LS's 72 through 79) during a severe winter, a number of deer (perhaps 100 animals) are expected to be exposed to the oil spill along the estimated average of 70 km of shoreline (assuming that 50% of the estimated total of 141.5 km of oiled shoreline is on the east side of Shelikof Strait) were contaminated by the spill. Some deer that ingest unweathered, highly toxic oil on kelp or other oiled intertidal vegetation are expected to suffer lethal effects. Other deer sublethally affected by ingesting plants oiled by weathered and less-toxic oil are expected to experience reduced fitness and survival. However, the number of deer killed or seriously affected by the spill (perhaps ≤ 100) are expected to be replaced by population recruitment within 1 year.

<u>Noise and Disturbance Effects from Exploration and Development Activities</u>: Exploration and development transportation and support traffic patterns are assumed to be about the same as under the base case, although air- and vessel-traffic levels are expected to be greater under the high case. Noise and disturbance (from air and vessel

traffic) effects on brown bears black-tailed deer, and other terrestrial mammals are expected to be about the same as described under the base case (temporary displacement within 1 mi of air and vessel traffic).

Summary: Noise and disturbance effects from air (60-120 helicopter trips/month) and marine-vessel (60 boat trips/month) traffic are expected to have short-term- (a few minutes to < 1 hour) displacement effects on brown bears, moose, and other terrestrial mammals within about 1 mi of the traffic routes when nearshore. The assumed 50,000-bbl-oil spill is expected to result in the loss of a small number of river otters (perhaps ≤60), a small number of brown bears (perhaps ≤ 10), and a number of Sitka black-tailed deer (probably < 100). More river otters (≥ 100) and brown bears (perhaps ≥30) are expected to be affected by the spill through contamination of intertidal habitats and prey, with this effect lasting for > 1 year (perhaps 3 years). However, regional populations of river otters, brown bears, and other terrestrial mammals are not expected to be affected by the spill or by the overall effect of exploration and development activities associated with the high case.

Conclusion: The overall effect of the high case on terrestrial mammals is expected to include the loss of small numbers of river otters (perhaps 50 or fewer), brown bears (perhaps ≤ 10) and black-tailed deer (perhaps ≤ 100) with recovery of brown bears and river otters and their habitats taking more than 1 year (perhaps 3 years) and recovery of black-tailed deer taking about 1 year. However, regional populations of terrestrial mammals are not expected to be affected by the high case.

h. Effects on the Economy: Increased employment is the most significant economic effect generated by the Alternative I high case. Employees would work on the construction, operation, and servicing of facilities associated with the sale. These facilities are described in the estimated and assumed base-case scenario, Table II.A.1, and are 11 exploration wells, 17 delineation wells, 11 production platforms; 198 production/service oil wells, 1 shore base constructed, and 150 mi of pipeline.

For the high case, direct OCS resident employment on the western side of the Kenai Peninsula would start with 795 in 1997; rise to 1,015 in 1998; drop to 401 in 1999; rise to 1,414 in 2000, to 3,174 in 2001, to 3,825 in 2002, and to 4,177 in 2003; drop to 2,839 in 2004 and 2,578 in 2005; and vary between 2,578 and 2,636 through the year 2020. Indirect resident employment is estimated to be 12.6 percent of direct OCS-resident employment and would peak at 526 for the year 2003. (See Appendix G for a description of methodology for employment and population forecasts. Also, see Sec. IV.B.1.h, Economy, for assumptions and general analytic methods used for this alternative.)

Resident employment on the western side of the Kenai Peninsula is estimated to be 15,986 for 1995 and is projected to rise 0.9 percent annually without the sale. Between the years 1997 and 2004, direct OCS employment and indirect employment would increase and decrease, resulting in changes of between 1 and 12 percent each year.

The OCS activity could generate effects on other facets of the economy including income, prices, and taxes. The OCS workers are likely to earn relatively high wages compared to the average income on the western part of the Kenai Peninsula. Assuming the income of the OCS workers was twice as high as the average for the western Kenai Peninsula, the effect on the average income would be to change it by < 11 percent for < 5 years. This is calculated using the largest rise for 1 year in direct OCS employment of 1,982 workers in 2001 compared to resident employment of 16,719 in 2000.

The < 11-percent rise in average income for < 5 years is the basic economic driving force of price inflation. The maximum rise in resident employment of 12 percent for 1 year, even assuming that the average income is twice the average for the KPB for 3,174 direct OCS workers, translates to price inflation of < 20 percent for < 5 years for the western Kenai Peninsula. Approximately half of the inflationary pressure will be in the demand for housing brought on by the fast rise in OCS workers with relatively high incomes. This inflationary pressure is lessened significantly by the assumption that about half of the construction workers will be housed in temporary quarters. After 3 years of exploration and delineation (1997-1999), there are 5 years (2000-2004) of shore-base and pipeline construction, platform installation, and well drilling. This brings a large increase in OCS employment in the period 2000 to 2003. Because of the relatively short time—7 years for the exploration and development phase—that housing would be needed for the large number of OCS workers, it is assumed that temporary housing would be provided by OCS lessees for approximately half of OCS workers in these 3 peak years. In the peak year 2003, temporary housing would be provided for about 2,100 OCS workers and permanent housing for the other 2,100 OCS workers.

i. Effects on Commercial Fisheries: In the high case, both exploration and production are assumed to occur in the sale area. Activities and events that may affect the Cook Inlet commercial-fishing industry include drilling discharges, offshore construction, seismic surveys, and oil spills. The effects of these activities and events on the Cook Inlet commercial-fishing industry are discussed in the base-case analysis in Section IV.B.1.i. The following high-case analysis focuses on the differences in the amount of activities and events estimated for the high case, as compared to that of the base case. It then estimates the resulting effect of this difference on the Cook Inlet commercial-fishing industry for the high case.

(1) Effects of Drilling Discharges: The base case estimates a total of 3 exploration, 5 delineation, and 48 production wells. This would release about 2,880 short tons of drilling muds and 3,520 short tons of drill cuttings in the exploratory phase and another 17,760 short tons of drilling muds and 26,880 short tons of drill cuttings in the production phase into marine waters. Because the high case estimates about four times the drilling activity (226 wells) estimated for the base case (56 wells), the high case is expected to have about four times the effect. However, due to the limited area affected near the platform-discharge point, drilling discharges are not expected to affect commercial fishing and are expected to have a minimal effect on commercial fishing.

(2) Effects of Seismic Surveys: The base case estimates that a total of 11 seismic surveys would be required for the three exploration wells, five delineation wells, and three production platforms. For the high case, an estimated 39 seismic surveys would be required for 11 exploration wells, 17 delineation wells, and 11 production platforms. However, as discussed in the base-case analysis, seismic surveys, planned and coordinated with the commercial fishing industry, are expected to have a minimal effect on the Cook Inlet commercial-fishing industry.

(3) Effects of Offshore Construction: The estimated amount of offshore construction is based on the number of bottom-founded production platforms and the associated dredging that occurs during pipeline construction. The base-case estimates that there would be three production platforms and 125 mi of pipeline construction, whereas the high case estimates that there would be 11 production platforms and 150 mi of pipeline construction. Hence, the high case estimates that there would be about four times as much offshore construction as estimated for the base case. As indicated in the base case, the offshore construction of platforms and pipelines is expected to result in some space-use conflicts (e.g., competition for docking space or gear loss). While these conflicts are expected to be more frequent in the high case (i.e., occasional), they still are expected to be minor in scope. For this reason, and due to the small area affected by platform and pipeline construction, offshore construction in the high case is expected to affect < 15 percent of the Cook Inlet commercial-fishing industry.

(4) Effects of Oil: The effects of a large oil spill on the Cook Inlet commercial-fishing industry were discussed in the base-case analysis. The high case also assumes one large oil spill (50,000 bbl). The high case differs from the base case only in the combined probability (expressed as percent chance) of one or more ≥1,000-bbl spills occurring and contacting land segments (1-2% for the base case; 1-9% for the high case), and in the number of land segments (16 for the base case; 30 for the high case). However, in terms of closures, these differences would not alter effects already discussed for the base case, because the amount of oil spilled in or near commercial-fishing grounds would be the same (50,000 bbl) and is likely to result in a similar number of closures. Hence, the effects of the assumed high-case oil spill on the Cook Inlet commercial-fishing industry are expected essentially to be the same as discussed for the base case; they are summarized below. Due to the relatively small amount of oil involved (2,242 bbl), the 198 small oil spills (Table IV.A.2-4d) estimated for the high case are not expected to result in closures or reduced market values over the life of the proposal. Hence, they are not expected to have a measurable economic effect on the Cook Inlet commercial-fishing industry.

The estimated economic effect of the large (50,000-bbl) oil spill on the Cook Inlet commercial-fishing industry is based on what occurred during the EVOS and GBOS, and primarily depends on the highly variable EVOS cost estimates (ranging from $9-43 million/year for 2 years). From 1983 to 1993, the value of the Cook Inlet commercial fishery appears to have ranged between about $50 and $135 million/year. Based on the above, in any 2-year period when the value of the Cook Inlet commercial fishery is estimated to be about $50 million/year, a 2-year loss of about $9 million/year represents an 18-percent/year loss for 2 years; whereas a 2-year loss of about $43 million/year represents an 86-percent/year loss for 2 years. In a 2-year period when the value of the Cook Inlet commercial fishery is estimated to be closer to $135 million/year, a 2-year loss of about $9 million/year represents a 7-percent/year loss for 2 years; whereas a 2-year loss of $43 million/year represents a 32-percent/year facilities and the production platforms could interfere with subsistence harvests as a result of disturbance, but such events should be localized and subject to mitigation if consistently encountered.

Accidental small oil spills offshore (the majority of which are estimated to average 9 bbl) are not expected to reduce subsistence resources or harvests, because such spills present little difficulty in cleanup.

Accidental large oil spills ≥1,000 bbl could affect subsistence harvests. There is a 72-percent chance of one or more spills ≥1,000 bbl occurring in the high case and a 70-percent chance of one or more spills ≥1,000 bbl occurring and contacting land after 30 days (Appendix B, Tables B-1 and B-14). Land segments from the OSRA model are used here to represent community subsistence-harvest areas. These land segments, the same as those used in the base case, correspond as closely as possible with the subsistence-harvest areas mapped in Figures III.C.3-3, 4a and b, and 5. The representations are as follows (see Fig. IV.A.1-2 for land-segment identification):

<u>Cook Inlet</u>:	
Tyonek	LS's 32-34, 36-37
Central Kenai Peninsula	LS's 38-40
Southern Kenai Peninsula	LS's 41-44
Nanwalek and Port Graham	LS's 44-46, 49-51
<u>Kodiak and Afognak Islands</u>:	
Akhiok	LS's 67, 88-90, 95-96
Karluk	LS's 67-69, 96
Kodiak road-connected area	LS's 67-90, 94-96
Larsen Bay	LS's 68-70
Old Harbor	LS's 85-90, 95
Ouzinkie	LS's 70-82
Port Lions	LS's 70-81
<u>Alaska Peninsula</u>:	
Ivanof Bay	LS's 1-4
Perryville	LS's 1-7
Chignik Lake	LS's 1-9
Chignik and Chignik Lagoon	LS's 1-12

(a) **<u>Cook Inlet</u>:** For the Tyonek subsistence-harvest area land segments, the mean number of one or more spills ≥1,000 bbl estimated to occur and contact land segments over the assumed 19-year-production life of the lease-sale area in all cases is estimated to be less than one (Appendix B, Table B-14). Land segment 32, representative of the southern extremity of the Tyonek subsistence-harvest area, shows an estimated 9-percent chance that one or more spills ≥1,000 bbl would occur and make contact within 30 days. Elsewhere along the shoreline used by Tyonek residents (LS's 33, 34, 36, 37) the chance of one or more oil spills ≥1,000 bbl occurring and contacting land segments ranges from 5 percent (LS 33) within 30 days to <0.5 percent.

Spills starting at pipeline- or tanker-transportation segments are estimated to have a <0.5- to 26-percent chance of contacting the southerly extremity of the Tyonek subsistence resource-harvest area (LS's 32 and 33) within 30 days during summer (assumed April-September). Land segments 32 and 33 generally coincide with the shoreline located south of Harriet Point. Elsewhere along the shoreline used by Tyonek residents (LS's 34, 36, and 37), the chance of spills contacting land from transportation segments does not exceed 2 percent (Appendix B, Table B-10). This characteristic of LS 37 indicates a very low chance of oil reaching the main Tyonek subsistence-harvest areas located north of the Sale 149 boundary. These and earlier data suggest that effects on subsistence harvests from oil spills should be limited, since the bulk of the area used for Tyonek subsistence harvests (north of Harriet Point) is estimated to be very little affected by oil-spill contact.

On the western and southern shores of the Kenai Peninsula (LS's 38-46 and 49-51), the combined probability (expressed as percent chance) of one or more oil spills ≥1,000 bbl occurring and contacting land segments for central and southern Kenai Peninsula communities and for Nanwalek and Port Graham ranges from <0.5 to 3 percent, with land segments for the southern Kenai Peninsula (LS's 42-45) showing a range from 1- to 3-percent chance of occurrence and contact within 10 and 30 days. The mean number of one or more ≥1,000-bbl spills

Land segments 80 through 90, located on the east side of Afognak and Kodiak Islands, show chances of contact ranging from <0.5 to 6 percent, with possible contact from two to four transportation segments for any one land segment. Elsewhere on the islands, the chances of contract from transportation segments is <0.5 percent.

The subsistence-harvest area for Ouzinkie and Port Lions (represented by LS's 70-82) is the most heavily contacted by oil spilled from transportation segments, should that occur. However, effects on subsistence harvests in Ouzinkie and Port Lions from spill contacts should be limited due to the large size of the harvest area.

The road-connected Kodiak community uses the entire area of Kodiak and Afognak Islands for subsistence harvests, yet 90 percent of all households use an area represented by LS's 82 through 86 (Zone 1, as shown on Fig. III.C.3-5) for any harvest activities. This area shows a very low estimated chance of contact (≤6%) from transportation spills, should they occur, during summer or winter within 30 days (Appendix B, Tables B-10 and B-13). Because of this, little direct effect on subsistence harvests from spills is expected among Kodiak road-connected residents.

Akhiok (LS's 88-90, 95-96, and 97) and Old Harbor (LS's 85-90 and 95) use the southern extremities of Kodiak Island for subsistence harvests. This part of Kodiak Island shows a very low (<0.5-3% in winter after 30 days) extent of contact from transportation segments, which suggests a comparable level of reductions on subsistence harvests for these communities. Karluk (LS's 67-69 and 96) and Larsen Bay (LS's 68-70), on the other hand, use a stretch of coast along the southern reaches of Shelikof Strait, which also is contacted to a very low (<0.5-2% in winter after 30 days) extent by oil from transportation segments, should such spills occur. As a consequence, there should be no measurable changes in the availability, accessibility, or desirability of subsistence resources and little change in the amounts of subsistence harvests among these Kodiak Island communities.

(c) Alaska Peninsula: On the Alaska Peninsula, LS's 1 through 9 represent the aggregate subsistence-harvest area for Chignik Lake, Ivanof Bay, and Perryville, and LS's 1 through 12 represent the aggregate subsistence-harvest area for Chignik and Chignik Lagoon, with LS 12 located the closest to the lease-sale area. There is a <0.5-percent chance of one or more spills ≥1,000 bbl occurring and contacting these land segments; the mean number of one or more spills ≥1,000 bbl spills to occur and contact land segments over the assumed 19-year-production life of the lease-sale area in these cases is estimated to be less than one. The chance of contact from transportation segments is very low, with a high single-source chance of contact of no more than 2 percent after 30 days for LS's 10 through 12. Under these circumstances, there should be no measurable changes in the availability, accessibility, or desirability of subsistence resources and little change in the amounts of subsistence harvests among these Alaska Peninsula communities.

The mitigating measures that encourage offshore operators to protect birds and mammals, catalog and protect newly discovered biological populations and habitats, and orient personnel to regional biological and cultural characteristics could provide increased levels of protection for subsistence resources and activities on a site-specific basis. Although these measures of protection provide no means of ensuring the avoidance of accidental oil spills, which are a primary threat to subsistence resources and activities, the measure dealing with the transportation of hydrocarbons provides that the method used to transport hydrocarbons from the sale area considers the social, environmental, and economic consequences of pipelines. This measure should assist in reducing the possibility of accidental spills where pipelines are involved. The measures on oil-spill-response preparedness and the identification of sensitive areas to be considered in oil-spill-contingency plans should provide a measure of protection to subsistence resources should an oil spill occur. There could be an indeterminable increased level of effect if these mitigating measures are not used for the proposed lease sale.

Summary: Effects on subsistence-harvest patterns in the high case would be most prominent among southern Kenai Peninsula communities, including the communities of Nanwalek and Port Graham. These communities would experience subsistence-resource loss, primarily because of the high level of exposure to spills from transportation segments. Such losses would include the lack of resource availability, accessibility, or desirability for use. Based on the EVOS experience (see Sec. III.C.3), harvest-level reductions estimated at 30 to 50 percent of average annual yields could occur in the first year of a spill, with substantial recovery thereafter.

Elsewhere in Cook Inlet and on Kodiak Island and the Alaska Peninsula, effects on subsistence-harvest patterns are estimated to be limited in magnitude and duration and not of such a nature as to cause measurable changes in the availability, accessibility, or desirability of most subsistence resources.

purposes of analysis but concrete information, plans and programs for extracting the oil for market. The announcement of a commercial discovery and field potential as well as the initiation of the process to prepare a developmental EIS again have the potential for revisiting the psychological, sociocultural, and sociopolitical stress and disruptions as in the prelease phase, although the stakes at that time should be different. The question then would be more as to how development would take place than whether the leasing action should take place at all. Because of this, there is a greater opportunity to mitigate expected impacts through stipulation, mediation, or negotiation than during the prelease process.

(b) **Changes in Industrial Activities and Population Levels:** The majority of resident population generated by the high case is assumed to reside within the KPB. Table IV.B.11.k-1 shows a forecast of resident population for the KPB with and without the sale and an estimate of the portion of such population that could reside in the communities of Kenai and Homer, if the ratios of 1990 population within the KPB were to pertain. The forecast of KPB resident population with and without the sale is derived from use of the RAM model, an explanation of which is contained in Appendix G. The estimates for Kenai and Homer were derived from the proportions displayed in the 1990 U.S. decennial census of population, with Kenai city accounting for 15.5 percent and Homer city accounting for 9.0 percent of total KPB population.

As shown in Table IV.B.11.k-1, the lease sale is estimated to increase the resident population in the KPB initially from around 1,100 to 2,800 residents to a more long-term, average figure of around 7,000 residents, with a peak in 2003 of nearly 11,500 residents. When these estimates are applied to the KPB as a whole, sale-related activities would account initially for about 3 to 7 percent and reach a peak of 21.5 percent of total resident population in 2003, with a long-term prospect of contributing about 13-14 percent of total KPB resident population. As might be expected, these proportions generally also would hold true for Kenai and Homer, if we assume that the sale-related population increases would be distributed uniformly within the KPB the same as was found in the 1990 U.S. census of population. This assumption is questionable, however, due to the location of the oil- and gas-industry facilities on the Kenai Peninsula. The more-likely prospect is for the preponderance of sale-related resident population to reside in the central peninsula area of the KPB (Table III.C.4-1 identifies the communities and CDP's covered in this area), where the service and support facilities for the Cook Inlet oil and gas industry are located. Because the central peninsula area of the KPB contained about half the KPB population in 1990, Table IV.B.11.k-2 shows the result of halving the forecast for resident population without the sale and then adding all resident population resulting from the sale to these figures.

Using this approach, the added increase of around 23 to 27 percent of total resident population (with a 3-year peak of around 30-35% in the years 2001-2003) is not a significant amount in terms of fostering changes in values or institutions within the central Kenai Peninsula area. The characteristics of the new segment of resident population should be compatible with the character of the central-peninsula resident community and should do little to change sociocultural patterns existing there, because the character of activity and the social and cultural orientations of the persons expected to be involved should be compatible with the recent historical experience of the community. However, an increase in resident population of such magnitude is significant in that the oil and gas segment of the resident population would tend to dominate other aspects of the community and/or spread more widely the social and cultural influence of this segment of the population to the fringes of the central Peninsula and beyond.

(c) **Changes in Subsistence-Harvest Patterns:** As discussed in Sec. IV.B.11.j, effects on subsistence-harvest patterns in the high case would be most prominent among southern Kenai Peninsula communities and the communities of Nanwalek and Port Graham. There is an estimated 72-percent chance that one or more oil spills ≥1,000 bbl would occur and an estimated 70-percent chance of one or more spills ≥1,000 bbl occurring and contacting land within 30 days (Appendix B, Tables B-1 and B-14). As a result, these communities would experience subsistence-resource losses, primarily because of the high level of exposure to spills from transportation sources. Such losses would include the lack of resource availability, accessibility, or desirability for use. Reductions in subsistence-harvest levels for specific resources could extend for more than a year.

The social consequences of such effects among southern Kenai Peninsula communities and the communities of Nanwalek and Port Graham could be serious. This is especially so in the Alutiiq communities of Nanwalek and Port Graham, where subsistence is a core cultural institution with complex social meaning. Threats to the subsistence resources and activities that are so fundamentally embedded within Native culture threaten that very culture itself and the meaning it gives to daily life (IAI, 1990). In addition to anxiety over the loss of subsistence resources and the quality of the habitats that nurture them, the *Exxon Valdez* experience showed heightened and

Table IV.B.11.k-2
Alternative Distribution of Sale-Related Resident Population within the Kenai Peninsula Borough (KPB): Mid-Peninsula Area; High Case

Year	Mid-Peninsula Total Resident Population without Sale	Sale-Related Resident Population	Mid-Peninsula Resident Population with Sale	Mid-Peninsula Percentage of Increase
1997	19,848	2,183	22,031	9.9
1998	20,027	2,787	22,814	12.2
1999	20,207	1,102	21,309	5.2
2000	20,389	3,883	24,272	16.0
2001	20,572	8,717	29,289	29.8
2002	20,757	10,505	31,262	33.6
2003	20,944	11,471	32,415	35.4
2004	21,133	7,797	28,930	27.0
2005	21,323	7,080	28,403	24.9
2006	21,515	7,080	28,595	24.8
2007	21,708	7,081	28,789	24.6
2008	21,904	7,080	28,984	24.4
2009	22,101	7,081	29,182	24.3
2010	22,300	7,094	29,394	24.1
2011	22,501	7,214	29,715	24.3
2012	22,703	7,239	29,942	24.2
2013	22,907	7,212	30,119	23.9
2014	23,114	7,198	30,312	23.7
2015	23,322	7,198	30,520	23.6
2016	23,531	7,199	30,730	23.4
2017	23,743	7,198	30,941	23.3
2018	23,957	7,199	31,156	23.1
2019	24,173	7,198	31,371	22.9
2020	24,390	7,198	31,588	22.8

Source: MMS, Alaska OCS Region.

experience. Institutionally, communities would undergo considerable disruption and community conflict, with litigation constituting a secondary source of postspill social and community stress.

Conclusion: In the high case, sociocultural systems in the central Kenai Peninsula area would be more highly dominated by the values and orientations of the oil and gas sector of the resident population, and one or more southern Kenai Peninsula communities would undergo periodic episodes of increased individual, social, and institutional stress and disruption that would last for several years in each instance and endure in memory for decades; effects are caused by both prelease and potential post-lease processes and events

l. Effects on Archaeological and Cultural Resources: This section provides a discussion of the potential environmental effects that could occur in the event that discovered, economically recoverable hydrocarbon resources in the Sale 149 area reached an assumed 800 MMbbl of oil. It is estimated that one large ≥1,000-bbl spill, 187 spills with an average size of 5 bbl, and eight spills with an average size of 160 bbl may occur during the life of the lease. Infrastructure expected to be used to explore and develop these resources includes 28 exploration and delineation wells, 198 development wells, and 11 platforms. The population increases due to the high case are about the same as for the base case.

The estimated conditional probabilities are the same for the base and high cases. The combined probabilities of one or more spills ≥1,000 bbl occurring and contacting increase only marginally from the base to the high case. Therefore, the effects due to contact (conditionals) and occurrence and contact (combineds) are assumed to be the same for the base and high cases (see Sec. IV.B.1.1 for details). The analysis of effects uses the same rationale as the base case. Because of the larger amount of oil produced, the effects of direct oil contact and disturbance to archaeological resources would be greater than the base case. Because the effects of routine operation and maintenance activities such as rig placement, pipeline construction, and facility construction would be mitigated, there would be few effects from these, the same as for the base case. Because more oil would be produced, there would be slightly more disturbance to shore sites due to small oil-spill-cleanup operations because the number of probable small spills would increase and more personnel would be required for cleanup operations. These factors would increase the effects by an estimated 2 percent of all resources to an estimated 5 percent of all the resources.

Conclusion: Effects on archaeological and cultural resources would be due to the activities of exploration personnel, increased site visitation, and oil-spill-cleanup activities. Effects from the high case on archaeological resources are expected to result in effects to an estimated 5 percent, or 50 sites.

m. Effects on National and State Parks and Related Recreational Places: This section provides a discussion of the potential environmental effects that could occur in the event that undiscovered, economically recoverable hydrocarbon resources in the Sale 149 area resulted in an assumed 800 MMbbl of oil. These estimates are considerably higher (about four times) than the base case for the proposal. Infrastructure expected to be used to explore and develop these resources includes 28 exploration and delineation wells, 198 development wells, and 11 platforms. The population increases due to the high case would be significantly higher then that of the base case. Depending on the phase of activity, OCS-generated population for the high case would reach 2.5 to 3 times that of the base case. In the high case, between 2005 and 2020, there would be an approximate addition of 2,600 resident workers to the Kenai peninsula over the base case. Thus there would be the potential for a significant increase of visitors to national and State parks and related recreational places as it is assumed that the majority of the workers would have families of varying sizes.

An effect of the EVOS was the cancellation by some potential visitors to Alaska. A public-relations campaign to quell such cancellations cost Exxon $15 million (Anchorage Daily News, 1989). Interior Alaska and Anchorage tour operators reported cancellations. Major cruise lines, which require deposits from customers, appeared least affected by the oil spill. The biggest effect was felt by small charter-boat, lodge, and sportfishing operations that normally would get much of their bookings just before the summer season. The cancellations occurred at an accelerating rate within a month of the spill. A major southeast fishing lodge, normally booking 25 to 30 people a week in late April, dropped to 0 bookings per week. It normally received 40 calls per week and, after the spill, received 15 calls—and half the callers asked about the oil's effect on fishing (Anchorage Daily News, 1989).

Oil from the EVOS reached Katmai on April 30, 1989 about 33 days after the spill occurred. The spill contacted beaches from Shaw Island on the north to Wide Beach on the south. Land Segments 32 through 42 were oiled. One sheen observed on about April 29, 1989, was 2 mi long and 10 mi wide. A fairly continuous slick of mousse quality effects associated with this proposed lease sale. The USEPA-approved OCD model was used to calculate the effects of pollutant emissions from the proposal on onshore air quality. Because the Class I PSD areas allow for the least amount of degradation, the modeling scenario (i.e., source location) chosen for this analysis is the one that results in the maximum-potential effect to the air quality of the designated national wilderness area of the Tuxedni National Wildlife Refuge, the only Class I area adjacent to the proposed sale area. The maximum-potential effect at any location in the Class II area would be the same. In all likelihood, effects to the Tuxedni National Wilderness Area would be lower than those calculated by the model.

For the high case, peak-year emissions from exploration would be from drilling five exploration wells and eight delineation well from two rigs. Peak-year emissions from development would include platform and pipeline installation and the drilling of 60 production wells from six rigs. Peak-year production emissions would result from operations (producing 69 MMbbl of oil), transportation of oil from six rigs (3 platforms), and transporting the oil by pipeline. Table IV.B.11.n-1 lists estimated uncontrolled-pollutant emissions for the peak-exploration, development and production years. Under the Federal and State of Alaska PSD regulations, because the estimated annual uncontrolled NO_x emissions for peak-development year would exceed 250 tons per year, the lessee would be required to control NO_x emissions through application of BACT to emissions sources to reduce NO_2 emissions (Table IV.B.11.n-2). The OCD model air-quality analysis performed for air pollutants emitted for exploration, development, and production in the high case showed that maximum NO_2 concentration, averaged over a year, would be 0.29, 0.88, and 0.54 μ/m^3, respectively, at the shoreline; 11.6, 35.2, and 21.6 percent, respectively, of the available Class I increment for NO_2; and 1.16, 3.52, and 2.16 percent, respectively, for Class II. (Other pollutants also were modeled; however, NO_2 had the highest concentrations, which were well within PSD increments and air-quality standards.) For a more detailed discussion of the potential effects of air pollution, other than those effects addressed by standards, see Section IV.B.1.n.

Accidental emissions could result from gas blowouts, evaporation of spilled oil, and burning of spilled oil. For the high case, the probability of experiencing one or more blowouts in drilling the 198 exploration, delineation, and production wells would be 14 to 17 percent. The emissions from a given gas blowout would be quickly diffused and would seldom last longer than a day. For additional information on gas blowouts, see Section IV.C.1.n.

Oil spills are another accidental source of gaseous emissions. Under the high case, one 50,000-bbl spill is assumed. Smaller spills <1,000 bbl would occur more frequently than larger spills. The number of small spills estimated for the high case is 193, totaling 2,242 bbl over the life of the field.

The burning of spilled oil in the high case would not differ appreciably from the base case. For any given fire, it is expected that any smoke reaching the shore would be dispersed, of short term, and limited to a local area, resulting in a low effect.

Effects at Nikiski, Alaska, and West Coast Ports: For a more detailed discussion, see Section IV.B.1.n(4). Assuming 53 tanker trips per year to west coast ports using 100,000 DWT tankers, tanker-loading operations in the peak-production year would result in an estimated 16 tons per year of SO_2, 13 tons per year of NO_x, 4 tons per year of PM-10, and 917 tons per year of VOC. Air-quality effects from SO_2 and NO_x would be insignificant. Effects from VOC emissions also would be insignificant because of the low potential for ozone formation in the area.

No increase in refinery throughput is expected if it is assumed that Sale 149 crude would displace North Slope oil that is currently received from the Valdez terminal. No change in refinery emissions would then be expected.

During tanker-unloading operations at west coast ports, emissions of NO_x, SO_2, PM-10, and VOC would result from tanker-exhaust stacks and fugitive losses. Because of the relatively low number of tankers that would visit a particular port, the mitigating requirements that are in place, and because it is expected that Sale 149 crude oil would displace at least part of the oil coming from other sources, no significant air-quality effects would be expected from tanker operations at west coast ports.

Conclusion: The effects associated with this alternative essentially would be the same, qualitatively, as those discussed for the Alternative I base case. Effects on onshore air quality from high-case air emissions are expected to be 35.2 percent of the maximum allowable PSD Class I increments. Only the Tuxedni National Wilderness Area is designated Class I, with the remaining area in and adjacent to the sale area designated Class II. Therefore,

Table IV.B.11.n-1
Estimated Uncontrolled Emissions for the Cook Inlet Sale 149
Alternative I--High Case[1]

	Regulated Pollutants				
	CO	NO_x	PM-10	SO_2	VOC
Peak Exploration Year	107.0	562.0	44.0	45.0	17.0
Peak Development Year	713.9	3307.8	246.4	445.0	154.6
Peak Production Year	325.6	1133.0	71.5	51.7	53.9

Source: MMS, Alaska OCS Region, 1993; computed from factors in Form and Substance, Inc., and Jacobs Engineering Group, Inc., 1989.

[1] Assumes peak-year emissions from exploration from drilling five exploration wells and eight delineation wells from two rigs. Peak-year emissions from development would include platform and pipeline installation and the drilling of 60 production wells from 6 rigs. Peak-year production emmissions would result from operations (producing 67 MMbbl of oil), and transportion.

Table IV.B.11.n-2
Comparison of Modeled Air-Pollutant Concentrations with Regulatory Limitations
(in micrograms per cubic meter)

Averaging Time	Maximum Modeled Concentration Over Land[2]	PSD Increments[1] Class I/ Class II	Air-Quality Standard
High-Case Exploration NO_2 (annual)[4]	0.29	2.5/25	100[3]
High-Case Development NO_2 (annual)	0.88	2.5/25	100[3]
High-Case Production NO_2 (annual)	0.54	2.5/25	100[3]

Source: USDOI, MMS, Alaska OCS Region, 1993.

[1] Increment above ambient concentration allowed in a designated PSD area. Ambient baseline concentration for PSD not established for this area.

[2] Offshore and Coastal Dispersion Model.

[3] Annual arithmetic mean.

[4] Modeling was done on other pollutants and these results were lower than shown for NO_X.

the potential effects would be much less. These effects would not make the concentrations of criteria pollutants in the onshore ambient air approach the air-quality standards. Consequently, a minimal effect on air quality with respect to standards is expected. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore from exploration, development, and production activities, or accidental emissions would not be sufficient to harm vegetation. A light, short-term coating of soot over a localized area could result from oil fires.

o. Effects on Coastal Zone Management: In the high case, the negative effects of an oil spill are greater as a result of the increased probability of an oil spill as a result of transporting oil from the platform to Nikiski and from Nikiski to market. Although the magnitude and probability of the effects are greater than in the base case, the resources affected and the type of effects are the same. As a result, the Statewide standards and district policies that apply in the base case also apply in the high case. As noted in the base case, conflict with many of the Statewide standards and associated district policies often is unknown until a specific exploration or development and production plan is submitted. However, in the base case a potential for conflict was identified with the Statewide standard for habitats. This conflict also would be apparent in the high case.

Conflict with the habitat standard of the ACMP likely would not preclude development. The ACMP provides a format for mitigating potential conflicts. The MMS operating procedures and the mitigating measures associated with this sale—especially the ITL clauses for Oil-Spill-Contingency Response, Bird and Marine Mammal Protection, Sensitive Areas to be Considered in Oil-Spill Contingency Plans, Coastal Zone Management, and the stipulations on Density Restriction Related to Commercial Fishing Uses, and Minimizing Potential Conflicts Between Oil and Gas Industry and Fishing Activities—provide additional mechanisms to ensure that activities that may follow this sale avoid conflict with the ACMP.

Conclusion: As in the base case, potential conflict with the habitat standard of the ACMP is possible. Site-specific information is necessary to ensure there is no conflict with the policies related to coastal development; geophysical hazards; energy-facility siting; transportation and utilities; subsistence; air, land, and water quality; and historic, prehistoric, and archaeological resources; conflict is not inherent in the scenario.

12. Cumulative Case: The analyses of the cumulative case for Sale 149 involve consideration of the potential effects on (1) the physical and biological resources, sociocultural systems, and programs from activities associated with petroleum exploration, development and production, and transportation in the Cook Inlet and Gulf of Alaska Planning Areas (Fig. I.A.1) and the major projects listed in Table IV.A.7-1 and (2) migratory species from activities over their range, including the transportation of oil from Nikiski, Alaska, to the west coast (U.S.) and from industrial and municipal activities in Southcentral Alaska, and along the Pacific Coast of Canada and the United States. Migratory species include those species or species groups that migrate to and from Alaska and migratory as well as other species in other areas that might be affected by the transportation of Sale 149 oil—especially oil spilled along the transportation route.

For Sale 149, the major projects considered in the cumulative-effects analyses for the Cook Inlet Planning Area include past and future State of Alaska and OCS oil and gas lease sales and production, capital improvement projects, onshore mineral and coal development, and timber harvesting. These projects are listed in Table IV.A.7-1.

Tanker transport of oil potentially could affect migratory as well as other species in the event of an oil spill. As noted in Section II.A.2.b(3), any economically recoverable oil that might be discovered in the Sale 149 area would be transported through offshore pipelines to Nikiski and either refined for in-State sale or transshipped to the U.S. west coast. Should all of this oil be shipped out of State, it would generate approximately 45 trips per year from Nikiski, assuming the use of a 45,000-DWT tanker.

Also, the migratory species could be affected by activities throughout their range and along their migration routes. These activities are listed in Table IV.A.7-1.

Oil exploitation associated with Sale 149 would increase the level of activities affecting these environments and resources. The level of activities associated with potential exploitation of Sale 149 oil has been estimated in Section II.A, and the proportion contributed by these activities to the overall level of activities associated with the present and proposed projects is listed in Table IV.A.7-1. The amount of oil that might be produced as a result of Sale 149 (Alternative I base case) is estimated to range from 100 to 300 MMbbl; the analyses of the potential effects of Sale 149 was based on an assumed amount of oil equal to 200 MMbbl.

a. Effects on Water Quality: The activities most likely to affect water quality in CI/SS are (1) the permitted discharges from municipal wastewater-treatment facilities, seafood processors, and the petroleum industry; (2) accidental oil spills; (3) construction activities; (4) and releases from nonpoint sources. As noted in Section III.5.e, the quality of lower Cook Inlet water generally is good (unpolluted).

(1) Permitted Discharges: Municipal and industrial wastes discharged through a discrete conveyance, such as a pipe, or a series of conveyances, are classified as "point" sources (USEPA, 1990). Each point source is required to obtain an NPDES permit that specifies (1) the waste streams permitted for discharge and the allowed quantities of pollutants in those waste streams and (2) any monitoring requirements and schedules (Mahanes, 1992). The USEPA guidelines for issuing discharge permits require a determination that the permitted discharges will not cause unreasonable degradation of the marine environment. The permitted discharges, offshore construction activities, any accidentally spilled oil, and releases from nonpoint sources would add substances that may (1) be foreign to or (2) increase the concentration of constituents already present in the water column of CI/SS. In general, the added substances may cause sublethal effects in some marine organisms if concentrations are greater than the chronic criteria (for the protection of marine life) and lethal effects if concentrations are greater than acute criteria.

(a) Municipal Wastewater-Treatment-Facilities Discharges: There are 10 communities in the Cook Inlet area discharging treated municipal wastewaters into Cook Inlet or into waters connected to or flowing into the inlet (Table III.A.5-9). The wastewater-treatment facilities for Anchorage and four of the other communities consist of primary treatment; the other five communities provide secondary treatment of their wastewaters. The permitted discharge rates range from (1) 0.5 to 1.6 million gallons per day (gpd) for communities with populations of more than several thousand and (2) 10 to 31 thousand gpd for communities with populations less than 500. The total permitted discharge rate for these 10 communities is about 49 million gallons of wastewater per day. The facility with the largest permitted discharge is Anchorage's Point Woronzof Wastewater Treatment Plant—44 million gpd.

A summary of effluent-monitoring data for Anchorage Water and Wastewater Utility Point Woronzof Wastewater Treatment Facility is shown in Table III.A.5-10. For 1993, the effluent-discharge rate averaged 30 million gpd; the BOD averaged about 25,800 lb/day (4,700 tons/year); and the TSS averaged about 12,300 lb/day (2,240 tons/year). The average amount of zinc discharged was about 18 lb/day, or about 3.24 tons/year. Oil and grease discharges averaged about 5,360 lb/day (about 980 tons/year).

The other communities (or census-designated places), with populations that range from about 70 to 2,700, bordering Cook Inlet and Shelikof Strait use septic tanks or other individual systems to treat domestic and commercial wastewaters.

Municipal wastewater discharges are estimated to remain at about the present levels for the foreseeable future—about 5 to 10 years—and are not expected to affect the overall water quality in Cook Inlet.

(b) **Seafood Processors**: The commercial-fishing industry in the CI/SS area has, through the years, harvested a variety of finfishes and shellfishes that include salmon (king, red, coho, pink, and chum), herring, halibut, crab, shrimp, and various other species. A summary of the harvests for salmon, herring, halibut, and crab is shown in Table III.A.5-11. Commercial harvesting of the fishery resources generally occurs between April and October (Anonymous, 1992; International Pacific Halibut Commission, 1991).

The fisheries harvests are processed at various onshore and offshore facilities to produce a variety of products that include fresh, frozen, and canned meat and roe (from herring and salmon). The daily capacities of the various processing facilities range from <1,000 lb to several thousand tons. (Facilities that process >1,000 lb/day are required to have USEPA NPDES permits to discharge their wastes; facilities that process <1,000 lb/day are required to have State of Alaska Dept. of Environmental Conservation [ADEC] permits.) The number of onshore and offshore processors operating in the area varies with the species being harvested and from year to year.

Processing of the commercial-fish harvests generates wastes that usually are discharged into the waters adjacent to the onshore plant or into the waters in which the offshore processors are operating. These wastes mainly consist of highly biodegradable constituents such as tissue solids, oil and grease, viscera fluids, heads, bones, and other discarded material; major constituents that are not highly biodegradable are crab and shrimp shells (Jarvela, 1985). Estimates of the amount of waste generated during processing depend on the type of resource being processed; waste estimates for some of the major fisheries in Cook Inlet are shown in Table III.A.5-11 Assuming all the salmon, herring, and crab caught in Cook Inlet are processed in facilities located onshore or offshore in the area, and based on the landings of halibut in Homer and Kenai, the amount of seafood wastes generated during the "fishing season" from these fisheries might range from about 5.56 to 18.92 million pounds of organic matter (Table III.A.5-11).

Seafood-processing discharges are estimated to remain at about the present levels for the foreseeable future—about 5 to 10 years—and are not expected to affect the overall water quality of Cook Inlet.

(c) **Petroleum Industry**: Petroleum-industry discharges in Cook Inlet come from (1) exploration and development and production operations and (2) petrochemical-plant operations. This analysis will consider (1) the chronic criterion (for the protection of marine life) for SPM/turbidity to range from 100 to 1,000 mg/l (Sec. IV.B.1.a(1)(a)1)), (2) 15 μg/l to be the chronic criterion (for the protection of marine life) and 1,500 μg/l—a hundredfold higher level—to be the acute criterion for total hydrocarbons (Sec. IV.B.1.a(1)(b)2)a)), and (3) 10 μg/l to be the chronic criterion (for the protection of marine life) and 1,000 μg/l to be the acute criterion for TAH (Sec. IV.B.1.a(1)(b)2)a)).

1) **Exploration and Development and Production**: The types and levels of activities associated with exploration and development and production for Sale 149 Alternative I (base case) and their effects on water quality in CI/SS are analyzed in Section IV.B.1.a; this analysis is summarized in this section. The permitted discharges are associated with exploration and production and service-well drilling and production operations. Drilling muds and cuttings and produced waters are the most significant discharges associated with offshore operations and have received the most attention. The bulk constituents of drilling muds are nontoxic to marine organisms at concentrations reached shortly after discharge (NRC, 1983).

Bulk discharges of drilling muds, usually about 100 to 200 bbl at a time, may occur several times during the drilling of a well, when the composition of the drilling mud has to be changed substantially or when the volume exceeds the capacity of the mud tanks. Washed drill cuttings and a small volume of drilling-mud solids are continuously discharged during drilling operations; the discharge rate varies from about 4 to 40 cubic meters per day (m^3/day) (about 25-250 bbl)– the high amount is more characteristic of the discharges early in the drilling program (Menzie, 1982). When the drilling and testing of an exploratory well is complete, there may be a bulk discharge of between 1,000 and 2 400 bbl of drilling mud. The NRC (1983) notes that the vast majority of the drilling muds discharged into OCS waters have densities that range from 1.19 to 2.09 g/cm^3 (≈ 1,190-2,090 g/l). For the purpose of this analysis, it is assumed the density of the drilling muds discharged into CI/SS could range from about 1,000 to 2,000 g/l.

Production operations generate a variety of continuous and intermittent discharges. These discharges contain a variety of chemicals used to improve or restore production, prevent or inhibit the growth of bacteria, inhibit corrosion and the formation of scale, improve separation of oil from water, to clean facilities, and perform a variety of other functions. The rate of adding chemicals to the various operations that generate the discharges could range from <1 to several hundred gallons per month.

Produced waters constitute the largest source of substances discharged into the marine environment, and their discharge is an issue of significant concern because of the types and amounts of naturally occurring substances they may carry and the manmade substances that may be added. The amount of produced waters is expected to range from 9 to 74 percent of the amount of oil produced. The toxicity of produced waters mainly is caused by hydrocarbons, which include nonvolatile hydrocarbons (oil and grease) and aromatic hydrocarbons; however, as noted is Section IV.B.1.a(1)(b)2)c), the toxicity of the produced waters is expected to range from slightly toxic to practically nontoxic prior to discharge and mixing in the receiving waters. The mean concentration of nonvolatile hydrocarbons in the produced waters is estimated to range from about 19 to 36 mg/l and the total aromatic hydrocarbons (TAH) is estimated to range from about 8 to 13 mg/l. Concentrations of zinc and BOD are estimated to range from 0.03 to 0.42 mg/l and 413 to 518 mg/l, respectively (Sec. IV.B.1.a(1)(b)2)c)).

The potential effects in any of the areas where there are permitted discharges would last for about (1) 2 to 3 months for each exploration well drilled and (2) 20 to 30 years for development and production activities. Future procedures and technologies of treating and handling drilling muds and cuttings and produced waters may reduce or eliminate the amounts discharged.

a) **Federal Sale 149 (Alternative I, Base Case):** Drilling of the 3 exploration, 5 delineation, and 48 production and service wells could result in the discharge of an estimated 6,720 to 20,640 tons (dry weight) of drilling-mud components and 30,400 (dry weight) of cuttings. The total amount of (1) barium that might be discharged with the muds and cuttings is estimated to range from 2,498 to 7,672 tons, (2) mercury from 9 to 26 lb, and (3) cadmium from 25 to 78 lb (Table IV.B.1.a-2).

The amount of produced waters discharged as a consequence of producing 200 MMbbl of oil in 19 years is estimated to range from about 18 to 148 MMbbl, or more (Sec. IV.B.1.a(1)(b)2)). The amount of (1) nonvolatile hydrocarbons (USEPA oil and grease) that might be discharged with the produced waters is estimated to range from 60 to 933 tons (about 17-269 lb/day); (2) aromatic hydrocarbons is estimated to range from about 25 to 337 tons (7-97 lb/day); (3) zinc is estimated to range from about 0.1-11 tons (0.03-3 lb/day); and (4) BOD is estimated to range from 1,303 to 13,434 tons (376-3,874 lb/day) (Table IV.B.1.a-2).

b) **State of Alaska, Offshore:**

Proven and Developed Fields: Through 1992, the four offshore oil fields in upper Cook Inlet have produced about 933 MMbbl of oil since the mid 1960's. Peak production occurred in 1970, about 70 MMbbl, and subsequently has been declining; from 1987 through 1992, these fields generally have produced about 13 MMbbl/year. Future recovery from the Granite Point, McArthur River, Middle Ground Shoal, and Trading Bay fields is estimated to be about 104.2 MMbbl; the average production over 19 years is estimated to be about 5.48 MMbbl/year.

As noted in Section III.A.5.d(2)(c)2) for the offshore oil fields in upper Cook Inlet, the number of wells drilled annually has averaged about 11. If, in the future, 11 wells are drilled annually, the amount of drilling muds and cuttings discharged could range from 63,800 to 297,000 bbl; these estimates are based on muds- and cuttings-discharge rates of 5,800 to 27,000 bbl per well, as shown in Table III.A.5-12.

Based on the production (104.2 MMbbl of oil total—5.48 MMbbl/year average) and concentration estimates noted in Section IV.B.12.a(1)(c)1), production from the offshore oil fields in upper Cook Inlet is estimated to generate (1) 9.38 to 77.11 MMbbl (0.49-4.06 MMbbl/year average) of produced waters; (2) 31 to 486 tons (1.64-25.6 tons/year average) of oil and grease; (3) 13 to 176 tons (0.7-9.2 tons/year average) of TAH; (4) 679 to 6,999 (35.5-368.5 tons/year) tons of BOD, and (5) <1 to 6 tons (5 to 597 lb/year average) of zinc.

Undeveloped Fields: At present, the only undeveloped discovery is the Sunfish Field in upper Cook Inlet. Initially, the Sunfish Field was thought to contain 700 to 750 MMbbl of oil (Short, 1993). However, this amount has been reduced as a result of subsequent delineation drilling and the most recent estimate is 77 MMbbl. As noted in Table II.A.1, MMS estimates 3 exploration and delineation wells, 2 platforms, and 24 production and service wells would be needed to develop resources of 75 to 80 MMbbl in lower Cook Inlet. If 3 exploration wells and 24 production and services wells are drilled in the Sunfish Field, the amount of drilling muds and cuttings discharged might range from 156,600 to 729,000 bbl; these estimates are based on muds- and cuttings-discharge rates of 5,800 to 27,000 bbl per well, as shown in Table III.A.5-12.

For the production (77 MMbbl of oil produced during 19 years—4.05 MMbbl/year average) and concentration estimates noted in Section IV.B.1.a(1)(b)2)), production from the Sunfish Field is estimated to generate (1) 7 to 57 MMbbl of produced waters (0.36-3.00 MMbbl/year), (2) 23 to 359 tons of oil and grease (1-19 tons/year), (3) 10 to 130 tons of TAH (<1-7 tons/year), (4) 502 to 5,172 tons of BOD (26-272 tons/year), and (5) 0.04 to 4 tons of zinc (4-442 lb/year).

c) **Effects of Mixing the Discharges with the Receiving Waters**: The concentrations of discharged drilling muds initially may range from about 1,000 to 2,000 g/l. The particulate concentrations of the drilling discharges are expected to be greater than the SPM/turbidity chronic criteria, 100 to 1,000 mg/l, assumed for this analysis within about 100 m of the discharge point. Within about 100 to 200 m of the discharge point, mixing in the water column would reduce the concentrations by a factor of 10,000 to 1,000,000; the diluted concentrations are estimated to range from 1 to 200 mg/l. The concentration of SPM in lower Cook Inlet and Shelikof Strait ranges from about 1 to 50 mg/l. Most of the solids in the discharges settle rapidly to the seafloor where bottom currents disperse the finer particles.

When the produced waters reach the receiving waters, the concentrations of the nonvolatile hydrocarbons and TAH are estimated to range from 19 to 36 mg/l (19,000 to 36,000 μg/l) and 8 to 13 mg/l (8,000 to 13,000 μg/l), respectively. At the point of discharge, prior to mixing, the concentrations of the nonvolatile hydrocarbons and TAH in the effluents from the production facilities are estimated to be about an order of magnitude, or more, greater than the acute criteria of 1,500 μg/l for total hydrocarbons and 1,000 μg/l for TAH assumed for this analysis.

The nonvolatile hydrocarbons (oil and grease) in the produced waters from an oil-production platform might be diluted 1,000 to 1,000,000 times within several hundred meters of the discharge source. If dilutions are based on a rate at the lower end of the range—1,000:1—the concentrations of nonvolatile hydrocarbons within several hundred meters of the platform might range from 19 to 36 μg/l and the concentrations of TAH might range from 8 to 13 μg/l. These concentrations are well below the acute criteria of 1,500 μg/l for the nonvolatile hydrocarbons and 1,000 μg/l for the TAH that were assumed for this analysis but, in general, slightly greater than the chronic criteria of 15 μg/l for the nonvolatile hydrocarbons and 10 μg/l for the TAH. If dilution rates are about 10,000:1, the concentrations of nonvolatile hydrocarbons might range from about 2 to about 4 μg/l, and the concentrations of TAH might be about 1 μg/l; these concentrations are less than the respective chronic criteria assumed for analysis.

Mixing is a continuous process, and the rate will depend on the receiving environment's energy as derived from the currents and waves. Evaporation will remove some of the aromatic hydrocarbons from the water column; Jordan and Payne (1980) note that evaporation may remove the majority of the more volatile compounds within 24 to 28 hours after an oil spill. Also, biodegradation processes act to continuously change the hydrocarbon compounds in the waters.

The characteristics of the other constituents of the produced waters or other production related discharges are expected to be within the USEPA criterion and/or be diluted in the water column within an area <2 km^2 to background concentrations or levels that would not cause sublethal to lethal effects in marine organisms.

__Summary of Effects of Drilling Muds and Cuttings, Produced Waters, and Other Discharges on Water Quality:__ The discharge of drilling muds and cuttings, produced waters, and other discharges associated with exploration drilling are not expected to have any effect on the overall quality of the Cook Inlet water. Within a distance of between 100 and 200 m from the discharge point, the turbidity caused by SPM in the discharged muds and cuttings is expected to be diluted to levels that are less than the chronic criteria (100-1,000 mg/l) and within the range associated with the variability of naturally occurring SPM concentrations. Mixing in the water column would reduce the toxicity of the drilling muds which, in general, are practically nontoxic, to levels that would not be harmful to organisms in the water column. Mixing and weathering processes will continuously reduce the concentrations of the hydrocarbons in the produced waters and reduce the toxicities of the produced waters. Mixing also is expected to reduce the concentrations of the nonvolatile hydrocarbons and TAH's to concentrations that are less than the chronic criteria of 15 μg/l and 10 μg/l, respectively. In general, the amounts of additives in the other discharges are expected to be relatively small (from 1 to 100 or 200 g/month) and diluted with seawater several hundred to several thousand times before being discharged into the receiving waters.

2) __Petrochemical Plants:__ The petroleum-processing plants located in Cook Inlet are shown in Table III.A.5-13. The USEPA has authorized the Chevron and Tesoro Refineries and the Union Chemical plant under the NPDES to discharge processing wastes into Cook Inlet; the Chevron Refinery created refining operations in September 1991. The Phillips-Marathon LNG plant, not listed in the table, has a permit from the ADEC. These permits provide limits on certain effluent characteristics, some of which are shown in the table. Discharges from the petrochemical plants are not expected to degrade the Cook Inlet water quality.

(d) __Discharge Comparisons:__ A comparison of the relative amounts, within an order of magnitude or so, of some of the various discharges entering Cook Inlet is shown in Table IV.B.12.a-1; the data and assumptions used to estimate the quantities are noted in the tables or sections referenced in the table. The estimates in Table IV.B.10.a-1 indicate that the annual discharge of:

- waters from the municipalities (10,950 million gal) and oil-production facilities (100-824 million gal) are only a fraction of the amount discharged by the rivers and, added together, are <0.3 percent of the annual discharge of the Ninilchik River (285,000 million gal);

- suspended solids discharged from the municipalities (4.48 million lb), refinery (0.06 million lb), and drilling muds and cuttings (2.56-3.72 [Alternative I base case]) million lb) are similar in magnitude to the suspended sediment discharged by the Ninilchik River and only a fraction of the suspended sediments (80,123 million lb) discharged by the Knik, Matanuska, and Susitna Rivers;

- BOD or organic wastes from municipalities (9.41 million lb), seafood processors (5.56-18.92 million lb), and produced waters (0.34-3.56 million lb) are all about the same order of magnitude;

- oil and grease that might be discharged from oil-production facilities (0.03-0.25 million lb) are less than that discharged by the municipalities (1.96 million lb);

- zinc from the municipalities (6,486 lb) and in the produced waters (25-2,891 lb) is less than that discharged by the rivers (110,200-256,300 lb);

- mercury (2-9 lb) and cadmium (6-28 lb) in the drilling muds (Alternative I base case) are less than discharged by the rivers (mercury, 1,102-2,563 lb and cadmium, <11,018-25,631 lb); and

- barium (595-2,750 tons) in the drilling muds (Alternative I base case) may be greater than the amount discharged by the streams and rivers (149-487 tons); however, the estimate of the freshwater discharge is based only on the concentration of barium in the Susitna River at Gold Creek, and this discharge is about 1 percent of the measured mean annual discharge of streams and rivers.

Table IV.B.12.a-1
Estimated Annual Freshwater and Point-Source Discharges and Marine Water Transport into Cook Inlet

Discharge Source	Total Discharge(million gallons)	Suspended Sediments (million lb)	BOD or Organic Wastes (million lb)	Oil and Grease (million lb)	Settable Solids (million lb)	Zinc (lb)	Barium[1] (tons)	Mercury[2] (lb)	Cadmium[3] (lb)
Rivers (Total Table III.A.5-1)	13,520,000								
Knik, Matanuska, Susitna (Gold Creek)	14,484,000	80,123							
Susitna River (Gold Cr) Mean[4] Minimum Maximum	 2,352,000 1,320,400 3,071,700		(78)[5]			 196,300 110,200 256,300	149-487	<1,102-2,563	<11,018-779,690
Ninilchik River	285,500	7.43							
Municipalities									
Permitted Discharge Rates-MAL[6]	17,870	13.81	16.41						
Anchorage-Point Woronzof									
MAL	16,060	13.40	16.08						
Projected (Based on 1993 Data)[7]	10,950	4.48	9.41	1.96		6,486		36.5	
Seafood Processing[8]			5.56-18.92						
Produced Waters[9]									
State of Alaska									
Proven and Developed Fields [10] (104.2 MMbbl--5.48 MMbbl/year)	21-170		0.07-0.74	<0.01-0.05		5-597			
Undeveloped Fields (77] MMbbl--4.05 MMbbl/year)	15-126		0.05-0.54	<0.01-0.04		4-442			
Sale 149 (Alternative I--Base Case (200 MMbbl--17 MMbbl/year [Peak])	64-528		0.22-2.28	0.01-0.16		16-1,852			
Drilling Muds and Cuttings									
State of Alaska									
Proven and Developed Fields (11 wells/year)[11]	2.65-12.47								
Undeveloped Fields (12 Wells/Year for a 2-year Period)	2.92-13.61								
Sale 149 (Alternative I--Base Case [2001--20 wells])		2.56-3.72			23.04-33.48		595-2,750	2-9	6-28
Refinery[12]		0.06	0.07						
Alaska Coastal Current (Marine water input to lower Cook Inlet circulation--million gallons)	1,166,450,000-2,249,590,000[13]								

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[1] Based on dissolved barium in the Susitna River (Gold Creek) 27 to 38 $\mu g/l$.
[2] Based on dissolved mercury in the Susitna River (Gold Creek) <0.1 $\mu g/l$.
[3] Based on dissolved cadmium in the Susitna River (Gold Creek) <1 $\mu g/l$.
[4] Section III.A.5.b.
[5] Based on dissolved carbon in Susitna River (Gold Creek).
[6] Table III.A.5-6. MAL Monthly Average Limitation.
[7] Table III.A.5-7.
[8] Table III.A.5-8.
[9] Table III.A.5-11.
[10] Grainte Point, McArthur River, Middle Ground Shoal, and Trading Bay mean production for 19 years.
[11] Section III.A.5.d(2)(c).
[12] Table III.A.5-14.
[13] Section III.A.5.b.

Annually, 18,520,000 million (18.562 trillion) gal of freshwater from streams and rivers are discharged into Cook Inlet and an estimated 1,166,450,000 to 2,249,590,000 million (1,66.45-2,249.59 trillion) gal of marine water from the Alaska Coastal Current (ACC) enters the lower Cook Inlet circulation regime (Table IV.B.12.a-1); the ACC water may be about 60 to 120 times greater than the freshwater discharge.

(2) <u>Oil Spills</u>: Accidental oil spills also may occur in CI/SS as the (1) result of production from State of Alaska leases in the waters of Cook Inlet, (2) oil tankered from Valdez, and (3) Sale 149. The estimates of the number and size of the oil spills assumed for the cumulative case are based on exploration and production from (1) the State of Alaska offshore leases in upper Cook Inlet of about 181 MMbbl, (2) tankering of 500 MMbbl, and (3) OCS leases of 200 MMbbl of oil associated with Sale 149 (Table IV.A.2-2). For the cumulative case, it is estimated that 11 exploration wells would be drilled: 8 exploration wells would be associated with Sale 149 (Alternative I base case), and 3 wells with drilling in State of Alaska waters. One spill of 9 bbl is assumed to occur as a result of the drilling of the 11 exploration wells.

Based on OCS production-spill data, it is estimated there will be 123 small (<1,000 bbl) oil spills (Table IV.A.2-4d) and 2 assumed large (≥1,000 bbl) spills (Table IV.A.2-2). Small spills may be categorized as spills of (1) >1 but <50 bbl and (2) ≥50 but <1,000 bbl. For spills <50 bbl, the number of spills for the cumulative case is estimated to be 118, and the total amount of oil spilled is estimated to be 594 bbl; 117 spills with an average size of 5 bbl (Table IV.a.2-4b) and 1 spill of 9 bbl (Table IV.A.2-4b). For spills ≥50 bbl but <1,000 bbl, the number of spills is estimated to be 5, and the total amount of oil spilled is estimated to be 800 bbl; the average spill size is estimated to be 160 bbl (Table IV.A.2-4c).

Two large spills ≥1,000 are assumed to occur; the probability (expressed as percent chance) of one or more such spills occurring is estimated to be 64 percent. This EIS assumes the total amount of oil spilled as a result of the two large spills is 100,000 bbl; each spill size is assumed to be 50,000 bbl.

The 5-, 160-, and 50,000-bbl spills are the same size as the >1- but <50-, ≥50- but <1,000-, and ≥1,000-bbl spills estimated for Alternative I (base case) (Sec. IV.B.1.a(2)(b) and (c)). The 9-bbl spill is the same size as the >1- but <50-bbl spill estimate for Alternative I (high case) (Sec. IV.B.9.a(2)a)). The fate of petroleum in seawater is described in Section IV.A.2. The effects of the small and large spills are analyzed in Sections IV.B.1.a(2)(b) and (c) and IV.B.9.a(2)a) and summarized in this section.

Small spills (<1,000 bbl) are represented by 117 5-bbl spills, 1 9-bbl spill, and 5 160-bbl spills. At the end of 3 days assuming no cleanup, the oil from a small spill may be dispersed in a 1- to 11-km^2 area in concentrations of about 20 to 61 μg/l. The concentration of the dispersed oil 10 days after a spill is estimated to be between 3 to 14 μg/l in an area of about 9 to 48 km^2 and after 30 days, <1 to 1 μg/l in an area of 34 to 199 km^2. During the 3- to 30-day interval following a small spill, the concentration of oil in the water column is not expected to exceed the acute criterion, 1,500 μg/l, assumed for this analysis; however, the concentration of spilled oil is expected to exceed the assumed chronic criterion, 15 μg/l, for several days to weeks.

Small oil spills, as represented in this analysis by 5-, 9-, and 160-bbl spills, are not expected to have any degradational effects on the overall water quality of Cook Inlet. The small spills would degrade the water quality for a relatively short period of time, perhaps up to about 10 days, in areas of less than about 50 km^2. As noted in Section III.A.5.c(4)(e), the concentration of any of the various types of hydrocarbons in the water column generally are quite low or below detection limits. Also, the TOC's in the sediments of Cook Inlet are present in concentrations that indicate an unpolluted environment; the presence of hydrocarbons in the water column is transitory, but they can accumulate in depositional sedimentary environments.

It is assumed one of the large (≥1 000-bbl) spills will occur in the Sale 149 area and the other in State waters. If a large spill (≥1,000 bbl) occurs in the summer, the size of the discontinuous area formed by spreading oil from a 50,000-bbl spill after 3 days is estimated to be 190 km^2 (Table IV.A.2-1), and the concentration of oil dispersed into the water column is estimated to be 711 μg/l (Sec. IV.B.1.a(2)(c)). After 10 days, the slick would cover an estimated 912 km^2, and the concentration of dispersed oil is estimated to be 163 μg/l. Thirty days after the spill, the slick would cover an estimated 3,715 km^2, and the concentration of dispersed oil is estimated to be 21 μg/l.

If a large spill (≥1,000 bbl) occurs in the winter under open-water conditions, the size of the discontinuous area after 3 days is estimated to be 178 km^2 (Table IV.A.2-1), and the concentration of oil dispersed into the water column is estimated to be 911 μg/l (Sec. IV.B.1.a(2)(c)). After 10 days, the slick would cover an estimated 851 km^2, and the concentration of dispersed oil is estimated to be 214 μg/l. Thirty days after the spill, the slick would cover an estimated 3,548 km^2, and the concentration of dispersed oil is estimated to be 24 μg/l.

If a large spill occurs under broken-ice conditions, the size of the discontinuous area after 3 days is estimated to be 170 km^2 (Table IV.A.2-2), and the concentration of oil dispersed into the water column is estimated to be 3,020 μg/l (Sec. IV.C.1.a(2)(b)). After 10 days, the slick would cover an estimated 794 km^2, and the concentration of dispersed oil is estimated to be 400 μg/l. Thirty days after the spill, the slick would cover an estimated 3,311 km^2, and the concentration of dispersed oil is estimated to be 37 μg/l.

During the 3- to 30-day interval following a large spill in the summer or in winter during open-water conditions, the oil in the water column is not expected to exceed the total hydrocarbon acute criterion (1,500 μg/l) but is expected to exceed the chronic criterion (15 μg/l) for a month, or more. However, if a large spill occurred in the winter in broken-ice conditions, the concentration of oil in the water column is expected to exceed the total hydrocarbon acute criterion during the first part of the 10-day period following the spill; after 10 days, the concentration of spilled oil is expected to be below the total hydrocarbons acute criterion but greater than the chronic criterion for more than a month.

A large oil spill (≥1,000 bbl), as represented in this analysis by a spill of 50,000 bbl of crude oil, would degrade the quality of Cook Inlet water for a period of about a month or longer in an area that might extend over several thousand square kilometers. If the spill occurs within a relatively short period of time, as measured in hours, the hydrocarbon concentration in the water column generally is expected to be less than the acute criterion (1,500 μg/l) within several days. However, the hydrocarbon concentration may remain greater than the chronic criterion (15 μg/l) for a month or more.

(3) <u>Construction</u>: Trenching and burial activities associated with pipeline-laying operations are expected to temporarily increase the turbidity of suspended particulates in the water column along sections of a (1) 125-mi corridor for 6 to 8 months (base case [Sec. IV.B.1.a.(3)]) and (2) perhaps several months for a pipelines associated with development of the Sunfish Discovery. Construction activities are not expected to have any overall degradational effects on Cook Inlet water quality.

(4) <u>Nonpoint Sources of Pollutants</u>: Nonpoint sources of water pollution are multiple, diffuse sources of pollution (USEPA, 1990). Primary nonpoint sources of pollution include runoff from urban areas and communities, farms, and mining areas. The amount of hydrocarbons present in municipal runoff might be significant.

For this analysis, oil pollution from commercial and recreational vessels also is considered to be a nonpoint source of pollution because of the dispersed character of the sources. Between 1965 and 1980, there were a reported 269 nonpetroleum-industry oil spills; the reported amount of oil spilled for 206 of the spills was 22,746 bbl—no volume was reported for 63 spills (State of Alaska, AOGCC, 1981). (Nonpetroleum-industry spills included spills from fishing boats, vessels carrying refined products to communities, and other vessels.) During the same period, there were 271 petroleum-industry spills. The reported amount of oil spilled from 187 of the spills was 7,596 bbl—no volumes were reported for 84 spills. (Petroleum-industry spills included all spills of crude oil from production platforms and tankers and spills of refined products associated with exploration and development and production operations.)

Oil sheens observed on the water surface are another source of information about oil spills. During surveillance flights in Prince William Sound and the Gulf of Alaska between September 1989 and September 1990, 260 sheens observed were attributed to sources other than *Exxon Valdez*, i.e., fishing boats, recreational boats, and cruise ships (Taft, Egging, and Kuhn, 1993); the number of non-*Exxon Valdez* spills was about 31 percent of the total number of spills observed. The estimated amount of oil in these sheens totaled about 8,100 l (about 193 bbl: 1 bbl = 42 gal ≈ 159 l) and ranged from < 1 to 6,000 l (< 1 to about 143 bbl); the largest spill consisted of diesel fuel from a cruise vessel.

Small oil spills (< 1,000 bbl) from commercial and recreational vessels are not expected to affect the overall quality of Cook Inlet water. However hydrocarbons from a large (> 1,000-bbl) commercial- or recreational-vessel-oil spill are expected to degrade the overall quality of Cook Inlet water. These effects are the same as described for small and large spills that might occur as a result of activities associated with Sale 149.

Summary: The permitted discharges, accidentally spilled oil, construction activities, and releases from nonpoint sources would add substances that may be foreign to or increase the concentration of constituents already present in the CI/SS waters. In general, the added substances may cause sublethal effects in some marine organisms if concentrations are greater than the chronic criteria (for the protection of marine life) and lethal effects if concentrations are greater than acute criteria.

The permitted discharges include those from municipal wastewater-treatment facilities, seafood processors, and petroleum-industry operations. The data available suggest that for certain parameters, the discharges comprise a fraction of the substances naturally entering the waters of CI/SS or are within an order of magnitude of each other. The annual discharge of wastewater (10,950 million gal) and suspended particulates (4.48 million lb) from municipal wastewater-treatment facilities is estimated to be <0.1 percent of total discharge (18,520,000 million gal) of the streams and rivers entering CI/SS and <0.01 percent of suspended sediments (80,123 million lb) discharged into CI/SS. Municipal wastewater discharges are estimated to remain at about the present levels for the foreseeable future—about 5 to 10 years.

The most significant discharges from petroleum operations are drilling muds and cuttings and produced waters. Future production from offshore fields is estimated to be about 381 MMbbl—200 MMbbl in Federal water and 181 MMbbl in State waters—during the next 20 to 30 years. Drilling of the wells to explore and develop and produce this amount of oil is estimated to generate (1) 2,785 to 13,040 bbl of muds and cuttings from State waters and (2) 6,720 to 20,640 tons (dry weight) of muds and 30,400 tons (dry weight) of cuttings from the Sale 149 area. Although the amounts of muds and cuttings discharged into State waters and the Sale 149 area are reported differently for this comparison, the number of wells drilled in State waters (23) is about the same as drilled in the Sale 149 area (20) (Table IV.B.12.a-1). The total suspended sediments in the Sale 149 drilling muds and cuttings discharges are about 0.01 percent of the suspended sediments discharged by Cook Inlet streams and rivers. Producing 381 MMbbl of oil is estimated to generate a total of 97 to 824 million gallons (2.31-19.62 MMbbl) of produced waters, <0.01 percent of the annual amount streams and rivers discharge into Cook Inlet.

For discharges from petroleum-development operations, the areas of potentially toxic waters are estimated to range in size from 0.03 to 1.77 km^2 (100- to 750-m radius, respectively). Mixing is expected to reduce the concentration of the discharges in these areas an estimated 1,000 to 1,000,000 times. Outside the mixing areas, the concentrations of the added substances are expected to be about the same as the background concentrations of the same or similar substances. The potential effects in any of the areas where there are permitted discharges would last for about 2 to 3 months for each exploration well drilled and about 20 to 30 years for development and production activities.

The BOD and/or organic wastes in the estimated annual discharges from municipalities (9.41 million lb), seafood processing (5.56-18.92 million lb) and petroleum production (produced waters—0.34-3.56 million lb) are about the same order of magnitude. The estimated annual amount of oil and grease discharged from municipal wastewater-treatment facilities is about 1.96 million lb, and offshore petroleum production is about 0.03 to 0.25 million lb.

The annual amount of zinc in effluent discharge from municipal wastewater-treatment facilities is estimated to be about 6,486 lb and in the produced waters from offshore production platforms from 25 to 2,891 lb. These amounts are each about 3 percent and <1.5 percent, respectively, of the mean annual amount of zinc in the discharge of the Susitna River (at Gold Creek).

The discharge of drilling muds associated with Sale 149 development may introduce into Cook Inlet waters an estimated 595 to 2,750 tons of barium, 2 to 9 lb of mercury, and 6 to 28 lb of cadmium annually. (As noted above, the number of wells drilled in State waters [23] is about the same as drilled in the Sale 149 area [20].) This amount of barium may be greater than introduced by the rivers—based on a low estimate of 149 to 487 tons annually. The amount of mercury in drilling muds may be about 1 percent of the mercury in the streams and rivers and cadmium <1 percent of the amount in streams and rivers.

The discharge of drilling muds and cuttings and the routine discharges associated with oil production are not expected to degrade the overall quality of Cook Inlet water.

The concentrations of substances released into the water from the permitted discharges will be highest, and potentially could cause sublethal to lethal effects in marine organisms, during the time of the discharge in areas that generally are <2 km^2 (the size estimated for petroleum-exploration-drilling units and -production platforms); some of these discharges are intermittent, while others are continuous. The potential effects, based on present levels of discharges, in any of the areas where there are permitted discharges would last (1) the foreseeable future—5 to 10 years for municipal wastewater discharges, (2) about 7 or 8 months during the "commercial-fishing season," (3) about 2 to 3 months for each exploration well drilled, (4) about 20 to 30 years for production activities, and (5) "its life" for a petrochemical plant Nonpoint sources of pollutants also will last "a long time"—as long as there are municipalities, farms, and/or mines. Vessels, other than crude oil- or refined-product carriers, transiting the waters of CI/SS also are potential nonpoint sources of spilled oil; these spills are likely to be diesel fuel in amount that may range from <1 bbl to >100 bbl. Permitted routine discharges and small oil spills (<1,000 bbl) are not expected to affect the overall quality of Cook Inlet water.

The characteristics of the other constituents of the produced waters or other production-related discharges are expected to be within the USEPA criterion and/or be diluted in the water column within an area <2 km^2 to background concentrations or levels that would not cause sublethal to lethal effects in marine organisms.

The number of small (<1,000-bbl) accidental oil spills that might occur if oil is produced is estimated to be 123; the total volume of oil spilled is estimated to be 1,394 bbl (1 spill of 9 bbl, 117 spills that average 5 bbl in size, and 5 spills that average 160 bbl). At the end of 3 days assuming no cleanup, the oil from a small spill may be dispersed in a 1- to 11-km^2 area in concentrations of about 20 to 61 μg/l. The concentration of the dispersed oil 10 days after a spill is estimated to be between 3 to 14 μg/l in an area of about 9 to 48 km^2 and after 30 days, <1 to 1 μg/l in an area of 34 to 199 km^2. During the 3- to 30-day interval following a small spill, the concentration of oil in the water column is not expected to exceed the total hydrocarbon acute criterion, 1,500 μg/l, assumed for this analysis; however, the concentration of spilled oil is expected to exceed the assumed chronic criterion, 15 μg/l, for several days to weeks.

Accidental small oil spills (<1,000-bbl) are not expected to cause any overall degradation to the quality of Cook Inlet water.

There is an 64-percent chance of one or more spills ≥1,000 occurring; the assumed number of spills is two and the estimated size of the spill is 50 000 bbl. In the summer at the end of 3 days assuming no cleanup, the oil from a large spill may be dispersed in a 190-km^2 area in concentrations of about 721 μg/l (Table IV.A.2-1). The concentration of the dispersed oil 10 days after a spill is estimated to be about 163 μg/l in an area of about 912 km^2 and after 30 days 21 μg/l in an area of about 3,715 km^2. If the spill occurred in the winter, the size of the affected areas after the 3-, 10-, and 30-day time intervals would be less than for a summer spill, but the concentration of oil in the water column would be greater. The oil in the water column is not expected to exceed the total hydrocarbon acute criterion (1,500 μg/l) during the (1) 3- to 30-day interval following a large spill under open-water conditions and (2) 10- to 30-day interval after a large spill in broken ice. During the 3- to 10-day interval following a large spill, the oil in the water column is expected to exceed the total hydrocarbon acute criterion (1,500 μg/l) under broken-ice conditions. The concentration of total hydrocarbons in the water column during the winter may exceed the acute criterion (15 μg/l) for >30 days.

A large oil spill (≥1,000 bbl) would degrade the quality of Cook Inlet water for a period of about a month or longer in an expanding area that might extend over several thousand square kilometers.

<u>Conclusion</u>: The permitted, routine discharges associated with municipal wastewaters, seafood processing, and oil and gas development and with small (<1,000 bbl) oil spills are not expected to cause any measurable degradation of Cook Inlet water quality. Water quality would be reduced from good (unpolluted) to polluted by the presence of hydrocarbons from one or more large (≥1,000-bbl) oil spills that have a 64-percent chance of occurring; one spill is assumed from Sale 149 Alternative I (base case) production and the other from offshore State production. Contamination from each spill (the presence of hydrocarbons in amounts >15 μg/l) would be temporary (last for a month or more) and affect an area of several thousand square kilometers.

b. Effects on Lower Trophic-Level Organisms: In addition to the base-case of the proposal, other activities associated with the cumulative case that may affect lower trophic-level organisms include the following: State oil and gas lease sales (Sales 78 and 85); State oil and gas fields (Granite Point, Trading Bay, McArthur River, Middle Ground Shoal, Swanson River, and Beaver Creek); oil and gas transportation (Drift River Oil Terminal, Alaska North Slope crude, and import tankering); noncrude carriers; and discharges from the Port of Anchorage. Nearby lumbering operations, wastewater discharges, and construction activities occurring in the sale area are not expected to affect lower trophic-level organisms at the population level.

Routine activities associated with these projects that could affect lower trophic-level organisms are the same as discussed for the base case in Section IV.B.1.b (seismic surveys, drilling discharges, and construction and dredging), although they would be more numerous than for the base case alone because of the additional State activities. Because of the prevalent use of airguns in Alaskan OCS waters and the apparent lack of effect on plankton and benthic organisms, seismic surveys associated with the cumulative case are expected to have little or no effect on lower trophic-level organisms. Drilling discharges are estimated to affect <1 percent of the benthic organisms in the sale area and none of its plankton. Affected benthic organisms are expected to experience mostly sublethal effects, but some would be killed. Recovery from drilling discharges is expected to occur within 1 year. Dredging and construction associated with the cumulative case are expected to have little or no effect on plankton communities. It is estimated that <1 percent of the immobile benthic organisms would be affected (mostly sublethal effects). Benthic invertebrates and plants needing a hard substrate for settlement are expected to colonize platforms in State and Federal waters within 1 or 2 years. Immobile benthic communities affected by pipeline construction are expected to recover in <3 years.

Accidental activities (oil spills) associated with the cumulative case that could affect lower trophic-level organisms also are the same as those discussed for the base case and are summarized below. For purposes of analysis, this section assumes that two 50,000-bbl spills occur, one in State waters and one in Federal waters. This contributes one 50,000-bbl spill to the assumed base-case oil spill of the same size. It also is assumed that lower trophic-level organisms largely have recovered from the effects of the first spill prior to the onset of the second spill. Because the cumulative case assumes that two oil spills occur, more oil is expected to reach the shoreline. This additional oil is expected to have similar effects on lower trophic-level organisms as described for the base case (i.e., it would double the total effects). Shoreline areas contacted by a second spill are assumed to be similar to the areas contacted by the first oil spill.

The effects of petroleum-based hydrocarbons on phytoplankton, zooplankton, and benthic organisms range from sublethal to lethal. Where flushing times are longer and water circulation is reduced (e.g., bays, estuaries, and mudflats), adverse effects are expected to be greater and the recovery of the affected communities is expected to take longer. Large-scale effects on plankton due to petroleum-based hydrocarbons have not been reported. Assuming that a large number of phytoplankton were contacted by an oil spill, the rapid replacement of cells from adjacent waters and their rapid regeneration time (9-12 hours) would preclude any major effect on phytoplankton communities. Observations in oiled environments have shown that zooplankton communities experienced short-lived effects due to oil. Affected communities appear to rapidly recover from such effects because of their wide distribution, large numbers, rapid rate of regeneration, and high fecundity. Large-scale effects on marine plants and invertebrates due to petroleum-based hydrocarbons have been reported. The sublethal effects of oil on marine plants include reduced growth and photosynthetic and reproductive activity. The sublethal effects of oil on marine invertebrates include adverse effects on reproduction, recruitment, physiology, growth, development, and behavior (feeding, mating, and habitat selection).

Based on the assumptions discussed in the text for the assumed base-case oil spill, each of the two large oil spills associated with the cumulative case is estimated to have sublethal and lethal effects on 1 to 3 percent of the phytoplankton and zooplankton populations and about 20 to 30 percent of the intertidal and shallow subtidal marine plants and invertebrates in the sale area. Recovery from each spill is expected to take 1 or 2 days for phytoplankton, up to 1 week for zooplankton, 2 to 3 years for marine plants and animals in high-energy habitats, and up to 7 years in lower energy habitats. The total percentage of plankton affected by each spill could increase to 5 percent if many embayments were contacted by a spill. Plankton recovery within the affected embayments is expected to take 1 to 2 weeks. Small oil spills (estimated total of 1,385 bbl) may adversely affect individual lower trophic-level organisms in small areas immediately around the spills. However, they are not expected to have perceptible effects on lower trophic-level organisms at the population level. As discussed in the base case, <5 percent of the subtidal benthic populations in the sale area are expected to be affected by oil.

Conclusion: Each of the two large oil spills assumed for the cumulative case is estimated to have lethal and sublethal effects on 1 to 5 percent of the plankton in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 2 weeks for zooplankton after each oil spill. They also are estimated to have lethal and sublethal effects on about 20 to 30 percent of the intertidal and shallow subtidal marine invertebrates in the sale area. This represents about twice the overall effect of the base case. Recovery is expected to take 2 to 3 years in high-energy habitats and up to 7 years in lower energy habitats. Less than 5 percent of the subtidal benthic populations in the sale area are expected to be affected. All of the above effects are based on the assumptions discussed in the text (e.g., the 50,000-bbl-oil spill occurs, and land segments having a chance of spill occurrence and contact ≥1 percent are assumed to be contacted).

c. **Effects on Fisheries Resources:** The primary factors that may have deleterious effects on finfishes in the sale area under the cumulative case are oil spills, noise and other disturbances associated with exploration and development (e.g., seismic activities, marine and aircraft traffic), oil-industry-related habitat loss and/or alteration, commercial and sport fishing, commercial-logging operations, and Native subsistence harvests. This analysis considers the potential effects of these factors on individual fish species, including the effects of the EVOS. The cumulative case assumes oil contact on fisheries resources and is different from the other alternatives and cases in the volume of oil assumed (includes State and OCS production), the location and extent of industrial activity, and the consideration of nonpetroleum-industry-related factors (fishing, logging, and Native subsistence).

(1) **Cumulative Effects of Sale-Specific and State Oil Spills:** To help estimate the potential effects of an oil spill for proposed Sale 149, an OSRA was performed for lower Cook Inlet. The OSRA is a model that estimates the combined probability of one or more ≥1,000-bbl-oil-spill occurring and contacting specific environmental resource areas. Actual spill effects on fisheries resources have been estimated using conditional risk contours, and conditional probabilities for transportation segments generated from the OSRA model.

(a) **Assumptions of the Probability Analysis:** The estimated mean number of spills is 1.01, and this analysis assumes two spills of 50,000 bbl for a total spill volume (combining both spills) of 100,000 bbl. A complete presentation of oil-spill statistics associated with this proposal is given in Section IV.A.2.

Conditional Probability Risk Contours: Probabilities derived from the conditional risk-contour maps (see Appendix B, Fig. B-1) are estimated by the OSRA model (expressed as percent chance) of a spill ≥1,000 bbl contacting any fraction of environmental resource areas, assuming a spill has occurred at specific platform locations in the sale area. Probabilities of contact of 5, 25, 50, 75, and 95 percent were calculated for most environmental resource areas. The areas adjacent to these resources, representing a chance of contact ≥25 percent for summer season 30 days, also were calculated and ranked according to size (Table IV.B.12.e-1).

Puale Bay (ERA 12), Outer Kamishak Bay (ERA 4), Hallo/Kukak Bay (ERA 9), and Katmai Bay (ERA 11) are most at risk to platform spills, as denoted by the total area where the chance of contact is ≥25 percent (Appendix B, Figs. B-12, B-4, B-9, and B-11). Of these areas, only ERA 4 could contain a platform under the base case. Thus, finfishes potentially affected by a platform spill, as denoted by the area where the chance of contact is ≥25 percent (ERA 4), are outmigrating salmonid smolts, herring eggs, juvenile pollock and pollock eggs, and some resident demersal fishes.

Conditional Probabilities: The conditional probabilities estimate the probability of a spill from a specific location contacting any fraction of environmental resource areas, land segments, or sea segments during the summer (April-September) or winter (October-March) seasons and at intervals of 3, 10, and 30 days. There are conditional probabilities for the proposed pipeline and tanker routes (see Fig. IV.A.2-5). The pattern of probability of contact (expressed as percent chance) for the various environmental resource areas derived from the OSRA model did not differ substantially from the summer to winter season. Thus, the primary difference in examining seasonal effects on these resources will be due to differences in the relative abundance of sensitive fisheries resources during the two seasons.

The conditional probability analysis is based on spill probabilities for transportation routes. Environmental resource areas with a conditional probability (expressed as percent chance) of contact >5 percent will be assumed as oiled. A spill near pipeline segment P3 would have a probability of contact (expressed as percent chance) to the following environmental resource areas: Tuxedni Bay (ERA 1), 6 percent; Chinitna Bay (ERA 2), 5 percent; Kachemak Bay (ERA 3), 40 percent; outer Kamishak Bay (ERA 4), 57 percent; inner Kamishak Bay (ERA 5), 24 percent; the Barren Islands (ERA 6), 5 percent; Cape Douglas (ERA 7), 12 percent; and Hallo/Kukak Bays (ERA 9), 5 percent. Finfish species from these environmental resource areas potentially affected by oil spills are: (1) returning adult salmon (king, red, pink, chum, and silver), steelhead trout, and eulachon transiting lower Cook Inlet; (2) outmigrating juvenile salmon entering Cook Inlet from natal rivers and streams along western Cook Inlet and southeastern Cook Inlet, including Kachemak Bay, particularly intertidally spawned pink salmon eggs in Kachemak Bay and around the southern portion of the Kenai Peninsula; (3) juvenile pollock and pelagic pollock eggs in the southern portion of lower Cook Inlet in the vicinity of Cape Douglas; and (4) demersal fishes (e.g., halibut, cod, and sablefish). For all other resources and land segments, estimated combined probabilities (expressed as percent chance) of one or more spills ≥1,000 bbl occurring and contacting are <5 percent.

Effects on fisheries derived from the EVOS studies were used to estimate potentially lethal effects of an oil spill on fisheries resources. Sale-specific oil-spill effects are not expected to directly affect returning adult salmon or steelhead. Oiled intertidal areas could cause an increased mortality to pink salmon eggs in the affected areas, but the increased egg mortality is not expected to cause reduced adult survival. An increased level of developmental malformations and increased egg-larval mortality could cause reduced survival to adulthood in herring populations affected by an oil spill. These effects are expected to be limited to the year-classes spawned during the spill year and be masked to some extent by the contribution of other year-classes to the herring population. Eggs and larvae of some semidemersal and demersal fishes may suffer increased mortality from oil contact. Also, some demersal fish populations could be exposed to oil in the event of a spill, and a few individuals could be killed. Based on experience of the EVOS: however, it is unlikely there would be any population-level effects to demersal fishes.

Indirect effects such as ingesting oil from contaminated food could cause slower growth of pink salmon juveniles due to the metabolic cost of depurating the hydrocarbon burden. This may cause an incremental reduction in survival to adulthood but is not expected to have population-level effects.

Fisheries resources could be disturbed and displaced from the immediate vicinity of drilling discharges within a radius probably not to exceed 100 m. These effects on demersal fishes very likely would be limited to only the short time periods of the discharge. Offshore construction also could temporarily disturb and/or displace fisheries resources. Any disturbance or displacement should be short term (hours to days), limited to only the time of construction and shortly thereafter. Though seismic-surveys may damage eggs and larvae of some fishes, this injury is limited to within a meter or two from the airgun-discharge ports. Thus, seismic surveys probably would have no appreciable adverse effects on fish populations.

The estimated mean number and the probability of such an oil spill (27% vs. 64% chance) occurring and the occurrence and contact of oil to various environmental resource areas is higher for the cumulative case than the base case. Further, two spills are assumed to occur under the cumulative case. Overall, the effects on fisheries resources due to oil spills from the cumulative case are not expected to be much different than those resulting from the base case. This is because effects to fish populations due to oiling generally are low and not expected to be as great as natural environmental perturbations.

(2) <u>Effects of Commercial Fishing on Fisheries Resources</u>: Probably the most substantial effects to fisheries resources under the cumulative case for the 19-year life of the proposal would be effects due to commercial fishing. There are seine, drift-, and setnet fisheries for salmonids throughout the Cook Inlet sale area and the larger Cook Inlet/Shelikof Strait Planning Area. Some of these fisheries (i.e., setnet and nearshore seine) can target specific fish species returning to their natal stream or river. But, because salmonids can and will transit along the nearshore areas in their return to natal rivers, even the setnet fisheries harvest mixed stocks of fish and multiple fish species. Also, many of the commercial-fishing methods take place in pelagic waters, where it is even less certain which stock is being harvested in the mixed-stock fishery at a given time. In recent years, so-called "intercept" fisheries have developed to harvest sockeye salmon in otherwise nontraditional fishing grounds for the targeted species (western side Kodiak fishing for Cook Inlet-destined sockeye and lower Cook Inlet fishing for upper Cook Inlet-destined fish). These intercept fisheries may reduce the amount of fish available for harvest at terminal commercial and sport fisheries. It is possible that intercept fisheries contributed to reduced fish harvests in upper Cook Inlet and unmet king and sockeye escapements for some streams in the Susitna River drainage. If management of these valuable resources does not adequately address the mixed-stock and intercept fisheries in Cook Inlet, certain finfish resources (sockeye, coho, and chinook salmon) could be overharvested during the 19-year life of the proposal.

A substantial trawl fishery exists in the sale area for semidemersal fish (groundfish, particularly pollock). Catches have declined steadily since the mid 1960's and 1970's. Although this fishery is managed closely by the North Pacific Fishery Management Council, there remains the possibility of overfishing during the 19-year life of the proposal.

In summary, commercial fishing is the most likely source to dramatically affect finfish abundance in the sale area over the 19-year life of the proposal. Species most-heavily fished (or incidentally caught) are most at risk, including sockeye and king salmon and walleye pollock.

(3) **Effects of Logging on Fisheries Resources:** Within the Cook Inlet region, timber harvests occur on the Kenai Peninsula and Afognak and adjacent islands. Timber harvest can affect local populations of finfishes by reductions in local invertebrate prey populations due to benthic bark accumulations at log-transfer facilities (LTF's). The LTF's can reduce invertebrate populations dramatically within the local area of the facility but usually only on the order of a few acres (Hanson, 1993, personal comm.). Effects from LTF's are expected to be minimal for finfishes in the cumulative case.

(4) **Effects of Subsistence Fishing on Fisheries Resources:** Certain finfishes are harvested by Native Alaskans for subsistence use. These fish resources include all species of salmon, eulachon, cod, and other fish species. This subsistence fishing warrants some consideration under the cumulative case. Details on subsistence fishing can be found in Section IV.B.1.j, Subsistence-Harvest Patterns.

(5) **Summary:** Effects on fisheries resources due to (1) indirect effects of oil spills and oil pollution, (2) noise and disturbance, and (3) habitat loss and/or alteration have been analyzed and appear in full in Section IV.B.1.c. The cumulative case considers the increased risk due to State-produced oil and nonpetroleum-related factors (fishing, subsistence, and logging) in assessing effects to finfishes. With respect to oil-spill risk, the basic differences between the cumulative case and the base case are (1) the number of spills assumed and (2) the volume of oil assumed to be discovered and produced.

An oil spill would have no appreciable adverse effects on adult pelagic fishes. Eggs and larvae of pink salmon, semidemersal, and demersal fishes could suffer increased mortality. Such mortality is not expected to have a population-level effect on pink salmon but may cause a reduction in survival of an entire herring year-class. Some individual demersal fishes are expected to be killed by the spill, but this mortality is not expected to affect demersal fish populations. Fisheries resources are expected to be temporarily disturbed and displaced by drilling discharges and offshore construction. These disturbances should be short term (hours to days). Seismic surveys may damage some eggs and larvae, but the injury is not expected to cause population-level effects. The probability of an oil spill and the occurrence and contact of oil to various environmental resources is higher for the cumulative case than the base case, and two spills are assumed to occur in the cumulative case. However, the effects on fisheries resources due to oil spills in the cumulative case are not expected to be much different than those resulting from the base case. This is because effects to fish populations due to oiling generally are low and not expected to be as great as natural environmental perturbations.

(a) **Commercial Fishing:** Commercial fishing is the most likely source to dramatically affect finfish abundance in the sale area over the 19-year life of the proposal. Species most heavily fished (or incidentally caught) are most at risk, including sockeye and king salmon and walleye pollock.

(b) **Logging:** Timber harvesting can affect local populations of finfishes by reductions in local invertebrate prey populations due to benthic bark accumulations at LTF's. The effect usually is very local, on the order of a few acres. Although the LTF's can affect fisheries resources by reducing their local foraging areas, this is expected to have minimal population-level effects.

(c) **Subsistence Harvest:** Fisheries resources are subject to harvest by Native Alaskans. The level of Native use is not well known and cannot be estimated for quantitative consideration here. For the purposes considered here, the Native subsistence harvest can be considered as part of natural environmental perturbations.

Conclusion: The overall cumulative effect on fisheries resources may include reduced stocks of some fisheries resources (sockeye, coho, and chinook salmon and some semidemersal fish such as pollock) primarily due to the potential for overharvest of these stocks by commercial-fishing activities. This effect could persist for several generations, or longer. The contribution of the proposal to the cumulative case is expected to be minimal with no population-level effects.

d. Effects on Marine and Coastal Birds: In this section, the cumulative effects of other past, ongoing, and planned projects, as well as the proposed action, on marine and coastal birds are discussed. Although the chance of any or all of the planned future and ongoing offshore and onshore projects reaching developmental stages generally is unknown, this analysis assumes that all the projects discussed in this section do reach developmental stages. These projects could affect marine and coastal birds through oil spills, noise and disturbance, habitat alteration, and other factors.

(1) Oil Spills from OCS and State of Alaska Oil and Gas Activities: The probability (expressed as percent chance) of one or more oil spills ≥1,000 bbl occurring increases to 64 percent, and two spills of 50,000 bbl are assumed under the cumulative case compared to a 27-percent chance of one or more spills occurring under the proposal for the base case (Table IV.A.2-2). The cumulative risk of spill contact to marine and coastal bird habitat areas is estimated also to increase over the base case of the proposal (Alternative I).

Cumulative State of Alaska oil-industry activities (25-30-year history) that include 14 oil- and 1 gas-production platforms located 2 to 8 mi offshore in upper Cook Inlet and proposed offshore and onshore oil and gas lease sales (67a and 76 in the Cook Inlet area in 1993 and proposed Sales 78 and 85 in Cook Inlet/Kenai Peninsula and Cook Inlet/Shelikof Strait in 1994 and 1996, respectively) also are estimated to increase oil-spill-contact risks to marine and coastal birds and their habitats in Cook Inlet and Shelikof Strait. One or more of the following bird habitats along the coast of the Alaska Peninsula have an estimated <0.5- to 95-percent (high) chance of oil-spill contact (assuming a spill occurs) from transportation activities in Cook Inlet within 30 days during summer: Cape Douglas (ERA 7) and Kukak Bay (ERA 9) and along the coast of lower Cook Inlet and Tuxedni Bay (ERA 1), Kamishak Bay (ERA's 4 and 5), Kachemak Bay (ERA 3), and the Barren Islands (ERA 6) (see Figs. IV.B.1.d-2, 3, and 4, and Appendix B, Table B-4).

One potential spill of 50,000 bbl from offshore oil activities associated with each of the Federal and State leases is assumed for this analysis and is expected to have the most noticeable effects on birds. Perhaps tens of thousands or more birds, particularly murres; other alcids; and sea ducks are expected to be killed as a result of oil spills over the life of these projects. Each of the two assumed oil spills (50,000-bbl each) is expected to have long-term effects on vulnerable species such as murres because (1) of the low reproductive rates of this species and other alcids, (2) little or no recruitment from unaffected colonies is expected (seabirds generally nest at the same colony where they were reared), and (3) the murre colonies on the Barren Islands are believed to have lost some breeding adult and reservoir nonbreeding birds to the EVOS.

If the spill contaminated coastal saltmarshes, several species of waterfowl and shorebirds are expected to suffer high losses (perhaps the loss of several thousand birds) due to direct oiling of the birds and contamination of prey organisms and subsequent oil ingestion. This would lead to reproductive failure during the year of the spill, and some effects may persist for a number of years (perhaps 2-3) after the spill.

A potential oil spill from tanker transportation of oil from offshore and onshore oil development in the Cook Inlet/Kenai Peninsula area and from the transportation of oil through Cook Inlet from Valdez (and to the southern U.S.) could have additional effects on marine and coastal bird populations of Cook Inlet/Shelikof Strait and the Gulf of Alaska.

The 1989 EVOS (11 million gallons or 260,000 bbl of oil) killed an estimated 375,000 birds—nesting seabirds plus overwintering waterfowl, shorebirds, and local raptor-bald eagle populations (Parrish, 1995, Ecological Consulting, Inc., 1991). Even 4 months after the spill, oil still persisted in coastal habitats; and it remained in a viscous state such that it continued to foul and kill many more coastal birds. Murre populations on the Barren Islands were reported to have declined by 60 to 70 percent and by 35 percent on the Triplet Islands (near Kodiak Island); and murre colonies of Puale Bay and Ugaiushak Island in the Shelikof Strait area also were affected by the spill (Nysewander and Dippel, 1991; Nysewander et al., 1993). The level of effect-recovery time for many Prince William Sound and Kenai Peninsula bird populations will be difficult or impossible to determine because little or no information was available on preoil-spill-population levels for affected species. The greatest estimated effect on murres was that local or portions of regional populations have experienced long-term (> 1 generation) effects, particularly the murre population on the Barren Islands. With the loss of the adult murres, the Barren Islands population lost synchronization of nesting activities in the last few years—egg laying was delayed by 1 month, which led to reproductive failure. The total replacement of experienced breeders lost to the spill is expected to take several years.

Marbled murrelets suffered losses between 10,200 to 22,000 birds, about 3 percent of the Alaska population from the EVOS (Kuletz, 1993; Piatt and Naslund, 1995). However, most of these losses occurred in the Prince William Sound population, although some losses occurred in the Cook Inlet/Shelikof Strait area. Long-term effects on some populations of marbled murrelets are expected as a result of potential oil spills and other development activities, as discussed below under effects of the commercial timber harvest.

Sea duck species suffered varying levels of mortality, depending on the species, and were displaced by oil-cleanup activities; but many species appear to be recovering 1 to 2 years after the spill (Hotchkiss, 1991). However, harlequin ducks were subject to considerable mortality in Prince William Sound (>400 ducks) during the spill and suffered reproductive failure in the 2 years following the spill; consumption of oil-contaminated mussels is suspected to be the cause (Patten, Gustin, and Crowe, 1991; Patten, 1993).

A substantial number (about 900) of bald eagles were directly killed by the EVOS, including birds that nested on Kodiak Island adjacent to the proposal. This represents about 11 percent of the population of 8,000 eagles in the areas affected by the spill (Bowman and Schempf, 1993). Reproductive success was significantly lower along oiled coastlines compared to unoiled coastlines in 1989 and 1990; and hydrocarbon-contamination exposure was indicated in eagle eggs, prey remains, and blood-serum samples collected from eagles in 1989 to 1990, including samples from Kodiak Island and the Alaska Peninsula (Schempf and Bowman, 1991). However, after the direct mortality from the spill, survival rates between eagles in oiled areas were not different from survival rates of eagles in unoiled areas (Bowman, Schempf, and Bernatowicz, 1995). Assuming an annual growth rate of 2 percent, the Prince William Sound bald eagle population was predicted to return to prespill size 3 years after the spill (Bowman, Schempf, and Bernatowicz, 1995).

If another large (≥100,000-bbl) tanker spill occurs in Prince William Sound or in Cook Inlet, a similar loss of birds (200,000-300,000) could occur, depending on the season and size of the oil spill and which species are concentrated in the spill area. If the Barren Islands area is contacted by another oil spill during the spring when adult birds are congregated on the water below the cliffs prior to breeding, or the spill occurs in the fall when flightless molting adults and young are rafting near the islands, substantial losses are expected to occur and population recovery is expected to take more than one generation.

Also estimated to occur under the cumulative case are 123 small oil spills (of ≥1 and to <1,000 bbl) (Table IV.A.1-4d). These minor spills are expected to have an additive effect on marine and coastal bird losses, perhaps increasing losses by a several thousand birds and increasing habitat contamination by perhaps 1 to 2 percent.

(2) **Effects of Noise and Disturbance:** Considerable amounts of air and vessel traffic have been associated with petroleum exploration in the Cook Inlet/Shelikof Strait area. For example, up to 720 helicopter trips per year are assumed to be associated with offshore development under the proposal. Such levels of traffic probably would result in some unrestricted low-elevation flights over concentrations of nesting, feeding, and/or molting birds. This disturbance is expected to have short-term (a few minutes to <1 hour) effects on some flocks of birds.

Noise and disturbance from air and vessel traffic from any one exploration and development project are likely to have a short-term effect on marine and coastal birds. However, the effects of cumulative aircraft and vessel traffic associated with tourism, sport fishing, and other recreation activities on the Kenai Peninsula, Kodiak Island, and other parts of the sale area as well as traffic associated with the oil industry are expected to result in long-term displacement (> 1 generation) of birds from some nesting and feeding habitats that are located near (within about 1 mi) airfields.

(3) **Effects of Commercial Fishing in the North Pacific:** Seabird mortalities due to marine oil spills are additive to the losses of seabirds that occur from the high-seas driftnet fishery in the North Pacific, Bering Sea, and Gulf of Alaska, where an estimated 250,000 to 750,000 seabirds are incidentally killed

each year; 33 percent of these losses are puffins and murres presumably that nest in the western Aleutians, and 60 percent of the losses are non-nesting Southern Hemisphere shearwaters wintering in the North Pacific (King, 1984). Such losses occur over a large geographic area in the North Pacific and probably do not seriously reduce the number of seabirds that nest in the Cook Inlet/Shelikof Strait area. However, an increase in the intensity of the fishing effort could increase the take of seabirds. Nearshore land-based gillnet fisheries can cause more serious losses on local seabird populations than the large offshore fisheries (DeGange and Day, 1991). Local salmon gillnet fisheries in British Columbia contribute significantly (7.8%) to the fall mortality of marbled murrelets (Carter and Sealy, 1984).

The growing exploitation of bottomfish, such as the pollock fishery in the Bering Sea and Gulf of Alaska including Shelikof Strait, theoretically could reduce the availability of prey to some seabird populations if pollock stocks collapsed (significant and substantial reduction of juvenile young age-class pollock) from future overharvesting. The present level of pollock harvest in the Bering Sea and Gulf of Alaska apparently has contributed to the recent drastic decline of northern sea lion populations in the southern Bering Sea and the Gulf of Alaska.

The possible development of other fisheries in Alaska, such as for capelin (as on the Atlantic coast), would result in direct competition between seabirds and commercial fishing for the same size fish and could result in significant seabird mortalities incidental to these fisheries (Brown and Nettleship, 1984; Piatt, Nettleship, and Threlfall, 1984).

Commercial fishing has had effects on seabird populations in the Pacific/Gulf of Alaska/Bering Sea regions as a whole, resulting in seabird mortality (250,000-750,000 bird losses/year); but specific seabird colonies in Cook Inlet/Shelikof Strait appear not to have suffered high mortality directly attributable to commercial fishing.

(4) The Effects of Past Fox Farming and Other Introduced Animals: Arctic and red foxes were the most widely introduced animals in Alaskan seabird habitat, although red foxes are native to the Alaska Peninsula and the easternmost Aleutian islands (Jones and Byrd, 1979). At least 6 of the 25 colonial seabird-species populations were significantly reduced by the introduction of foxes to their nesting grounds (Lensink, 1984). Fox farming was first established in about 1836 on the Aleutian Islands by the Russian-American (fur) Company and, by 1936, arctic foxes were introduced on almost every island from the Aleutians eastward to Prince William Sound and on some of the southeastern Alaskan islands (Jones and Byrd, 1979). Domestic cats and feral dogs have been introduced to some islands but appeared to have had no significant effect on seabird numbers (Jones and Byrd, 1979). With the removal of foxes from many islands, seabird populations have been recovering; however, because of the presence of introduced rats to many islands, burrow-nesting seabirds still are suffering mortality from introduced mammals (Bailey and Kaiser, 1993; Bailey, 1993).

The effect of introduced predator species on seabird populations, especially burrow-nesting species (such as puffins as well as auklets and murrelets), has been long term (several generations) and interregional with hundreds of seabird colonies affected, resulting in the probable loss of several hundreds of thousands or more seabirds due to these introductions. Some seabird colonies in Cook Inlet/Shelikof Strait have not recovered from these losses and are still being affected by predation from introduced rodents.

(5) Effects of Commercial-Timber Harvests on Afognak Island and the Kenai Peninsula: Marbled and ancient murrelets are two seabird species that nest in old-growth spruce-hemlock forests in the Pacific Northwest, including along the coast of the Gulf of Alaska and Cook Inlet/Shelikof Strait. Both species have lost nesting habitat from the clearcutting of old-growth forests along the coast (Sealy and Carter, 1984; Vermeer et al., 1984). Past intensive timber harvests in old-growth forests in California are believed to have resulted in a substantial population decline of marbled murrelets in that State, and further declines are expected to occur along the North Pacific coast, including British Columbia and Southeast Alaska, with the continued cutting of coastal old-growth forests (Sealy and Carter, 1984).

Within the Cook Inlet/Shelikof Strait area, the Afognak Native Corporation owns 82,000 acres on Afognak Island. Timber-harvest units range from [illegible]0 to 140 acres (Cuccarese et al., 1987). Annual harvests are expected to total 3,000 acres for the next 30 years, and about 20,000 acres have been harvested so far (Wiedmer, 1993, personal comm.). Other Native corporations also are involved in timber sales on Afognak and adjacent islands. Two logging camps and a log-transfer facility are located in Kazakof Bay on Afognak Island near an important wintering area for waterfowl (Graphic 4). There was a significant increase in logging activity in the coastal forests of Southcentral Alaska in the past 5 years, with approximately 120 million board feet cut in 1989 (Table IV.A.7-1).

The ongoing and proposed timber harvest of old-growth forests on Afognak Island are expected to affect marbled and ancient murrelet populations adjacent to the proposed sale area. Such loss of nesting habitat would be a long-term effect. At least a hundred years would be required for the logged areas, if left undisturbed, to return to old-growth habitat suitable for nesting marble murrelets (Sealy and Carter, 1984).

The old-growth-timber harvests on Afognak Island are expected to reduce marbled and ancient murrelet nesting habitat. Bald eagle-nesting sites are concentrated along the coast of Afognak Island (Graphic 4). The loss of old-growth forest is expected to result in some loss of nesting habitat, especially on Afognak Island. The loss of habitat is expected to represent a local reduction in bald eagle and ancient and marbled murrelet nesting distribution and productivity. However, if the Bald Eagle Protection Act is enforced on the timber-harvest tracts, a forest strip of a 330-ft radius of uncut timber would be left around all registered bald eagle nests. This measure is expected to reduce most disturbance and displacement of nesting eagles but would not avoid the loss of nesting habitat of murrelets.

__Summary__: Cumulative oil development, commercial fishing, commercial-timber harvest, past fox farming, and air and vessel traffic associated with the above development projects have had or are expected to have long-term (>1 generation) effects on marine and coastal birds in the Cook Inlet/Shelikof Strait area. The primary effects have been and are expected to come from (1) oil spills that are expected to result in the loss of several thousand to perhaps tens of thousands of birds and fishing nets that result in the loss of 250,000 to 750,000 birds in the North Pacific each year (but do not greatly affect the abundance of birds in the sale area); (2) alteration of nesting habitat due to commercial logging, which is expected to have a long-term (>1 generation) effect on the abundance and productivity of murrelets that nest in old-growth forest; (3) continued predation on burrow-nesting seabirds by introduced mammalian predators that has resulted in the loss of hundreds of thousands of seabirds in the past 50 to 100 years, with some populations of seabirds still subject to this predation with recovery not achieved; and (4) noise and disturbance from air and vessel traffic associated with most of the above activities causing short-term (a few minutes to <1 hour) and, perhaps for some species, long-term displacement from local areas near airstrips and marine ports. Other than potential oil spills, the proposal is expected to contribute short-term-local displacement effects on birds and long-term over the life of the proposal) local (within 1 mi) habitat-alteration effects (an estimated total of about 25 acres). This habitat loss is not expected to affect bird populations in the sale area.

__Conclusion__: The overall cumulative effect on marine and coastal birds is expected to involve the loss of tens of thousands (perhaps more than 00,000) of birds and the loss of thousands of acres of old-growth-forest habitat of some species (murrelets). This effect is expected to persist for more than one to several generations. The contribution of the proposal to the cumulative case is expected to include <50 percent of the mortality and <1 percent of the habitat loss.

e. __Effects on Nonendangered Marine Mammals (Pinnipeds, Cetaceans, and the Sea Otter)__: Nine species of nonendangered marine mammals commonly occur in the lower Cook Inlet sale area (for a description of these, see Sec. III.B.4). All marine mammals are protected species under the MMPA, as amended. The primary factors that may have deleterious effects on marine mammals in the sale area under the cumulative case are oil spills, noise and other disturbances associated with exploration and development (e.g., seismic activities, marine and aircraft traffic), oil-industry-related habitat loss and/or alteration, commercial and sport fishing, commercial-logging operations, and Native subsistence harvests. This analysis considers the potential effects of these factors on individual pinnipeds, cetaceans, and sea otters, including the effects of the EVOS, followed by population-level effects on a sale-specific basis. The cumulative case assumes oil contact on marine mammals and is different from the other alternatives and cases in the volume of oil assumed (includes State and OCS production), the location and extent of industrial activity, and the consideration of nonpetroleum-industry-related factors (fishing, logging, and Native subsistence).

(1) __Direct Effects of Oil Contamination__: Oil can affect marine mammals via ingestion, through direct contact with the skin surface, inhalation of petroleum hydrocarbon (PHC) vapors, or by the alteration of their normal patterns of behavior. The actual effects of oil contact on marine mammals (clinical symptoms, physiological effects, behavior alteration, etc.) are discussed in full only for the base case (Sec. IV.B.1.e).

(a) __Effects of Oil Spills, Including the *Exxon Valdez* Spill__: Oil spills of many types that have affected marine mammals to varying degrees have occurred over the last 26 years. No clear pattern has emerged regarding the effects of oil spills on marine mammals, though one expects differences depending on the species, season, and environment involved. Marine mammals known to have been contacted by the EVOS include the Steller sea lion, Pacific harbor seal, killer whale, and sea otter. Effects on the Steller sea lion can be found in the Endangered and Threatened Species section.

1) **Harbor Seals:** Nineteen recently dead seals (including 13 pups) were necropsied in 1989. Most necropsied seals were too decomposed for proper analysis, but two appeared to be hit by boats and some dead pups seemed to have suffered from malnutrition and stress. Twenty-eight seals were collected and examined; all appeared normal externally, though some were oiled. Effects included conjunctivitis; brain lesions; intramyelenic edema; high PHC metabolites in seal bile (indicative of oil inhalation, absorption, or ingestion); and increased levels of PHC's in blubber, mammary tissue, and milk (Frost and Lowry, 1993).

Aerial-survey-trend counts during the molt were made in oiled and unoiled areas during 1989, 1990, and 1991 in an attempt to estimate mortality due to the spill. Though the recent decline in Prince William Sound harbor seal numbers (Pitcher, 1989; Frost et al., 1991) complicated the analysis, lower trend counts in the oiled areas estimated 345 harbor seals killed by the EVOS (Frost and Lowry, 1993).

2) **Killer Whales:** Photo-identification studies on the AB pod indicated either unusually high mortality or missing whales—7 in 1989 and 6 in 1990, for a total of 13 missing whales in the 2 years postspill (Dahlheim and Matkin, 1993). The cause of death or whereabouts of these whales is unknown. Some speculate that the whales may have been displaced by the commotion associated with the spill and cleanup in 1989 and 1990 and have yet to be resighted (Loughlin, 1993a and b, personal comm.). Alternately, they may have been shot as a consequence of the black-cod longline fishery interaction with killer whales. Dahlheim and Matkin (1993) believe the 1989 missing animals were killed by the spill; and mortality in the year following the spill was due to long-term effects suffered in the spill year, though there is no direct evidence to support their beliefs.

3) **Sea Otters:** Effects of the EVOS on the sea otters of Prince William Sound, the Kenai Peninsula, and the Kodiak Island/Alaska Peninsula were profound. Sea otters contaminated during the spill suffered from a variety of ailments, including interstitial pulmonary emphysema, gastric erosion/ulceration and hemorrhage, renal and hepatic lipidosis and necrosis, hypothermia, stress, and shock. Stress and shock also were resultant from capture and cleaning. All of the above effects contributed to sea otter mortality associated with the EVOS (Lipscomb et al., 1993).

The minimum estimate of sea otter acute mortality, based on total number of carcasses, was 904 after adjusting for the number of otters that died prespill but recovered by spill-response teams. Extrapolation from an experiment on carcass-recovery rate estimated a total of 4,028 sea otter deaths resulting from the spill over the entire spill area, and 2,209 for Prince William Sound (Doroff et al., 1993). Sea otter spill-related acute mortality also was estimated by another method that compared ratios of animals counted in years prior to the spill to counts made after the spill. The number of sea otter deaths estimated from this method for Prince William Sound otters was 2,800, with a confidence interval of 500 to 5,000 otters (Garrott, Eberhardt, and Burn, 1993).

For a complete discussion of previous oil-spill effects on marine mammals, including the estimated effects from the EVOS on Prince William Sound harbor seals, killer whales, and sea otters, see Section IV.B.1.e, the base case.

(2) **Cumulative Effects of Sale-Specific and State Oil Spills:** To help estimate the potential effects of an oil spill for proposed Sale 149, an OSRA was performed for lower Cook Inlet/Shelikof Strait. The OSRA is a model that estimates the probability of one or more ≥1,000-bbl-oil-spill occurring and contacting specific environmental resource areas. Actual spill effects on these marine mammal resources have been estimated using conditional risk contours and conditional probabilities for transportation segments generated from the OSRA model.

(a) **Assumptions of the Probability Analysis:** The estimated mean number of spills in the cumulative case is 1.01, and this analysis assumes two spills of 50,000 bbl for a total spill volume (combining both spills) of 100,000 bbl. A complete presentation of oil-spill statistics associated with this proposal is given in Section IV.A 2.

The results from the conditional probability-risk contours and conditional probabilities for transportation segments do not change for the cumulative case. Mortality estimated from conditional probabilities appears in each species' section below.

Conditional Probability Risk Contours: The results from the conditional probability-risk contours do not change from those of the base case. The marine mammal species potentially affected by a platform spill as denoted by area where chance of contact is ≥25 percent, are nonendangered cetaceans, sea otters, and harbor seals at ERA 4. The complete analysis can be found in Section IV.B.1.e.

Conditional Probabilities: For the cumulative case, sale-specific and State spill effects on marine mammals were estimated by using conditional probabilities for transportation segments for two spills. One spill will be assumed from State production in Cook Inlet and the other, from OCS production, will be assumed to occur in the Gulf of Alaska, affecting resources determined by conditional probabilities >5 percent. These assumed spills are temporally distributed with a 5-year period between Spills 1 and 2. Mortality rates derived from the EVOS and adjusted by the Sale-Specific Mortality Factor (SF) were used to estimate potentially lethal effects of the spill scenarios on each species. For details on the assumptions of the effects analysis and the SF, see Section IV.B.1.e.

1) **Spill 1, Tuxedni Bay Area:** The hypothetical first spill occurs in lower Cook Inlet during summer in the vicinity of tanker and pipeline segment T1. This spill is estimated to contact Tuxedni Bay (ERA 1), the Forelands area (SS 1), South Kalgin Island (SS 2) in 3 days, with the highest chance of contact to South Kalgin Island (Appendix B, Table B-2). After 30 days, the estimated chance of contact increases slightly for Tuxedni Bay and South Kalgin Island, with no change for the Forelands area (Appendix B, Table B-4). Potentially affected animals include harbor seals and beluga whales at Tuxedni Bay, South Kalgin Island, and the Forelands area.

Effects on Marine Mammals from Spill 1: Harbor seals are the most likely pinniped species to receive contact from this spill. Seal habitat also would become oiled, causing seals to haul out in oiled areas and continuing their exposure to oil. Recent maximum counts on northwestern Cook Inlet from Tuxedni Bay to the Forelands and south to south Kalgin indicated a total of 363 seals in the potentially affected area. If these sites are assumed oiled, an estimate of harbor seal mortality using EVOS mortality rates and adjusting with the SF would be 23 harbor seals from Spill 1. The effect of such mortality on the seal population of lower Cook Inlet would probably be minimal.

Beluga whales are common in Cook Inlet and generally frequent shallow nearshore waters, bays, and estuaries. Belugas could be at risk from this spill in the northern part of Cook Inlet. Recently, as many as 242 belugas have been counted in Cook Inlet on a single day. It is possible that as many as 242 could be in the spill area. There are no data on the effects of oil on beluga whales in the wild. Furthermore, little is known about the Cook Inlet beluga population in terms of recruitment or mortality rates. Belugas tend to travel in groups and are medium-sized toothed whales, both characteristics shared with killer whales. One method of estimating potential beluga whale mortality from a hypothetical spill is to use killer whale data from the EVOS and apply the SF. This results in seven estimated beluga whale mortalities from Spill 1.

Because there are no good estimates of Cook Inlet beluga recruitment rates, they will be estimated using the NMFS (1991) general estimate for cetacean maximum net productivity (MNPL = 2%) X a recovery factor (.5) based on the status of the stock. For Cook Inlet belugas, a conservative population size is 500 individuals postspill, thus 500 (.02)(.5) = 5 individuals per year would be recruited into the population. Recovery to prespill numbers for Cook Inlet belugas would take about 2 years, although group age and social structure may take longer to recover.

No other marine mammals (fur seals; sea otters; gray, minke, and killer whales, Dall's and harbor porpoises; and Pacific white-sided dolphins) are expected to be contacted or suffer effects by Spill 1.

2) **Spill 2, The Gulf of Alaska:** The second hypothetical spill is assumed to occur well into the Gulf of Alaska along tanker segment T8 during summer, contacting environmental resource areas and land segments where the combined probabilities are >5 percent (5 years after Spill 1). This spill is not estimated to contact a single environmental resource area or land segment in the sale area after 3 days (Appendix B, Table B-2). But after 30 days, the chance of contact is estimated to spread to Marmot Island (ERA 24) at 9 percent, the Portlock Bank (ERA 25) at 27 percent, Middle and North Albatross Banks (ERA 23) at 20 percent, and SS 4 across Marmot Bay (Appendix B, Table B-2). Potentially affected animals include harbor seals

and sea otters around Marmot Bay; harbor seals on Ugak Island; and foraging fur seals; and gray, minke, and killer whales, Dall's and harbor porpoises; and Pacific-white sided dolphins around the banks.

Effects on Marine Mammals from Spill 2: Effects on foraging fur seals would be the same as under the base case (Sec. IV.B.1.e). Although 186 to 252 fur seals could be killed by the spill, this level of mortality would have minimal effects on the fur seal population.

Fewer harbor seals are at risk under this spill scenario than under Spill 1. About 358 harbor seals occupy eastern Kodiak Island from Marmot Bay south to Ugak Island. If these sites are assumed oiled, an estimate of harbor seal mortality from such a spill would be 22 estimated harbor seal mortalities from Spill 2. A loss of 22 harbor seals would have minimal effects on the regional population.

There are about 1,444 sea otters in the Marmot Bay area (northeast Kodiak Island), so mortality rates from hypothetical Spill 2 adjusted by the SF might be 121 estimated sea otter mortalities from Spill 2. Recovery to prespill numbers could take 1 to 2 years at a 5- to 10-percent annual rate of increase (Eberhardt and Siniff, 1988).

Effects on killer whales would be the same as under the base case (Sec. IV.B.1.e)—about two estimated killer whale mortalities. The population groups affected by Spill 2 would recover to prespill numbers in about 1 year, although pod age and social structure may take longer. Gray and minke whales, Dall's porpoises, Pacific white-sided dolphins, and harbor porpoises were estimated to be unaffected by a spill or, alternatively, the effects would be unmeasurable. Sea otter estimated mortalities indicate about 121 sea otters resident to the affected area will be killed. Recovery was estimated at 1 to 2 years.

b) Oil Spills Along The Transportation Route: It is possible that a spill could occur outside of the sale area and affect migratory marine mammals somewhere along the transportation route. However, because the estimated oil volume associated with proposed Sale 149 that potentially would be shipped to Los Angeles, for example, represents only 2.4 percent of the amount already arriving there (a similar proportion also is expected to be shipped to San Francisco), it appears that Sale 149 would contribute only a minor increment of oil-spill risk to populations of nonendangered migratory marine mammals over the current potential risk. Also, the estimated probability of a tanker spill in the potentially affected area is only 6 percent. The effects attributable to Sale 149 oil could vary considerably if the oil were refined in Alaska or shipped to foreign ports (this would require a law change), or if additional spills involving Sale 149 oil occurred in California over the estimated 19-year project period.

(3) Indirect Effects of Oil on Marine Mammals: Indirect effects of oil spills or oil pollution on marine mammals are changes in food supply, consumption of prey species that have become contaminated by bioaccumulated PHC's, and the bioaccumulation of PHC's in the tissues of individual animals. At this time, the indirect effects of oil on marine mammals are difficult to quantify. However, because cetaceans and pinnipeds (and probably sea otters) can metabolize and detoxify small quantities of ingested oil (St. Aubin, 1990; Geraci, 1990; Geraci and Williams, 1990), consumption of contaminated prey probably poses less risk to marine mammal populations than the direct effects of oil ingestion described above (Sec. IV.B.1.e(1)(c)). For a complete discussion of the potential indirect effects of oil on marine mammals, see Section IV.B.1.e.

(4) Effects of Noise and Disturbance on Marine Mammals: Noise and disturbance activities that may affect marine mammals in the proposed sale area include geophysical surveys, marine dredging and construction, support vessels, aircraft overflights, and offshore drilling and production. Marine mammal-population vulnerability to disturbance depends several factors, including (1) the number of animals involved, (2) the sensitivity of the species, (3) the presence of preferred habitat in relation to the disturbance, and (4) the characteristics of the disturbance source.

The loudest noise source created by industry activity was identified as seismic noise and is expected to have minimal effects on nonendangered marine mammals. Overflight disturbance reactions probably would be short term, with seals reoccupying haulouts and whales continuing their activities usually within a matter of hours. For a complete discussion of the potential effects of noise and disturbance on marine mammals, see Section IV.B.1.

(5) **Effects of Habitat Loss and/or Alteration on Marine Mammals:** Habitat loss or alteration would be limited to temporary disturbance to some sea otters and harbor seals in the nearshore environment associated with construction of pipeline and transport facilities. Disturbance from habitat alteration/construction activities would be relatively short term and very localized and should not affect marine mammal survival. For a complete discussion of the potential effects of habitat loss and or alteration on marine mammals, see Section IV.B.1.

(6) **Effects of Commercial Fishing on Marine Mammals:** Marine mammals are accidentally injured or killed as a result of certain commercial-fishing operations and, in some cases, intentionally harassed, injured, or killed. The National Marine Fisheries Service is responsible for managing these fishery interactions as mandated by the MMPA, as amended. Several of the marine mammal species may be subject to take by commercial fisheries and warrant consideration under the cumulative case. Estimated annual removal for these species for all of the Alaska Exclusive Economic Zone are <15 fur seals, <300 harbor seals, <10 beluga whales, <1 killer whale, <10) harbor porpoises, <10 Dall's porpoises, and <10 minke whale (USDOC, NOAA, NMFS, 1992a). For the purposes of the cumulative case, one-third of these numbers will be assumed to be the lethal take for these species in fishery interactions each year in the sale area. No estimate is available for fishery-related mortality in the sale area. Hoover-Miller (1994) states that the level of fishery-related mortality has not been well documented but appears to be decreasing. Since fishermen are becoming aware of the political consequences of shooting marine mammals, the incidences of intentional kill as well as the reporting of any kill are lower.

(7) **Effects of Logging on Marine Mammals:** Within the Cook Inlet region, timber harvests occur on the Kenai Peninsula and Afognak and adjacent islands. Timber harvest can affect local populations of marine mammals (particularly sea otters) by reductions in local invertebrate prey populations due to benthic bark accumulations at log-transfer facilities (LTF's). The LTF's can reduce invertebrate populations dramatically within the local area of the facility but usually only on the order of a few acres (Hanson, 1993, personal comm.). This can affect populations of sea otters and harbor seals by reducing their local foraging areas.

(8) **Effects of Subsistence Hunting on Marine Mammals:** Certain marine mammals are harvested by Native Alaskans for subsistence use. Fur seals, harbor seals, beluga whales, and sea otters all are subject to some level of lethal take by Native Alaskans. This subsistence take warrants some consideration under the cumulative case. Some information is available on the subsistence harvest of harbor seals. In 1992, the subsistence harvest of harbor seals by the communities in the vicinity of the sale area was estimated at approximately 96 animals, with an additional 5 animals struck and lost. An additional 50 animals were taken in Cook Inlet by communities north of the sale area (Wolfe and Mishler, 1993). The 1992 population estimate for Cook Inlet, including the Barren Islands area, was 2,443. Details on the subsistence take can be found in Section IV.B.1.j, Subsistence-Harvest Patterns and in Section III.C.3.

(9) **Summary:** Effects on marine mammals due to (1) indirect effects of oil spills and oil pollution, (2) noise and disturbance, and (3) habitat loss and/or alteration have been analyzed and appear in full in Section IV.B.1.e. The cumulative case considers the increased risk due to State-produced oil and nonpetroleum-related factors (fishing, subsistence, and logging) in assessing effects to marine mammals. With respect to oil-spill risk, the basic differences between the cumulative case and the base case are (1) the number of spills assumed to contact marine mammal resources and (2) the volume of oil assumed to be discovered and produced. There is no difference between the base and cumulative cases in the conditional probability analysis for the transportation segments that were used to determine potential effects on marine mammal species in the sale area. However, to estimate effects due to the increased risk of the cumulative case, two spills were considered rather than the one in the base case.

(a) **Spill Mortality:** Mortalities over the two spills have been assessed in the sale area using EVOS criteria adjusted by the SF for two different locations and timeframes. The total numbers of marine mammals potentially affected due to oil spills under the life of the cumulative case based on the two spills are 45 harbor seals, 121 sea otters, 7 beluga whales, 2 killer whales, and 252 fur seals. Recovery times could not be estimated for harbor seals due to their declining numbers, but the mortality level was not considered to affect the population. Estimates were made for sea otters and beluga and killer whales, and the longest recovery period calculated to reach prespill numbers was 2 years. The effects of the cumulative case due to oil spills likely would be minimal for fur seals, gray and minke whales, Dall's and harbor porpoises, and Pacific white-sided dolphins.

(b) **Commercial Fishing:** Estimated annual mortality due to commercial fishing for marine mammal species in the sale area are 5 fur seals, 100 harbor seals, 3 beluga whales, 3.3 killer whales, 33 harbor porpoises, 3.3 Dall's porpoises, and 3.3 minke whales. For worst-case estimates on annual mortality due to fishing, these numbers are assumed to be the lethal take for these species in fishery interactions, although they are probably overestimates. Over the life of the proposal (19 years), these annual mortalities sum to the following: 95 fur seals, 1,900 harbor seals, 57 beluga whales, 6 killer whales, 627 harbor porpoises, 63 Dall's porpoises, and 63 minke whales.

(c) **Logging:** Timber harvest can affect local populations of marine mammals (particularly sea otters) by reductions in local invertebrate prey populations due to benthic bark accumulations at LTF's. The effect usually is very local, on the order of a few acres. Although the LTF's affect marine mammals by reducing their local foraging areas, this is expected to have minimal population-level effects.

(d) **Subsistence Harvest:** Fur seals, harbor seals, beluga whales, and sea otters all are subject to some level of lethal take by Native Alaskans. The level of Native take is not known and cannot be estimated for quantitative consideration here. The NMFS currently considers Native subsistence harvest as "natural mortality" (Mello, 1993, personal comm.).

Conclusion: The overall cumulative effect on nonendangered marine mammals over the 19-year life of the proposal may include fairly large mortalities of harbor seals primarily due to commercial-fishing activities. This effect could persist for several generations, or longer. Mortalities to other marine mammals is expected to have minimal population-level effects. The contribution of the proposal to the cumulative case is expected to be minimal, with no population-level effects.

f. **Effects on Endangered and Threatened Species:** In addition to proposed Sale 149, several State and private projects or activities could contribute to the cumulative effects on endangered or threatened species. State or private actions reasonably certain to occur within or near the proposed sale area include State of Alaska Oil and Gas Lease Sales 78 and 85, transport of crude oil between Valdez and Nikiski or lower 48 ports, transport of crude oil from Cook Inlet to lower 48 ports, transport of refined petroleum products out of Cook Inlet, transport of liquefied natural gas from Cook Inlet to the Far East, commercial-fishing operations, subsistence harvests, and tourist-industry activities. The cumulative case assumes that in addition to a ≥1,000-bbl oil spill associated with Sale 149 proposal, one spill would result from oil production in State waters (Table IV.A.2-2). Winter-habitat loss, contamination, or disturbance outside the sale area also could contribute to cumulative effects on migratory species. Disease, predation, fluctuations in prey availability, or other natural factors presumably would contribute to the cumulative effect or affect the intensity with which anthropogenic factors operate.

(1) **Whales:** Generally, whales remain far enough offshore to be found mainly in Federal waters; however, in some areas (e.g., Cook Inlet/Shelikof Strait) fin or humpback whales, for example, do enter State waters where they could be exposed to potentially adverse factors associated with State leasing. If exploration and development and production activities occur on State leases, whales could experience disturbance effects similar to those described for the proposed action (Sec. IV.B.1.f). However, State-sale areas primarily are confined to areas north of Kachemak Bay, where endangered whale sightings are rare, and thus effects from these sales are not expected to increase overall effects on whales. Likewise, although State Sale 85 proposes to offer leases along both sides of Shelikof Strait, few migrating whales are expected to encounter activities associated with this sale, and any disturbance is expected to cause only brief behavioral responses. Migrating gray whales appear to ignore or exhibit minor temporary avoidance responses to all but nearby vessels and other potentially disturbing stimuli. Because fin and humpback whales are expected to respond similarly (Baker et al., 1983; Malme et al., 1985), their activities are not expected to be altered significantly.

Vessels carrying tourists to areas frequented by whales in Alaska are not expected to cause overall disturbance effects of the whale populations to increase significantly, except where whales are exposed routinely to vessel noise in constricted waters (e.g., humpback whales in Glacier Bay National Park/ Preserve); avoidance of local areas by whales may occur. However, gray whale behavior, which may represent that of endangered whales, appears to be minimally disrupted on their southern wintering range (Baja California) by whale-watching vessels, which are closely regulated by the Mexican Government (Jones and Swartz, 1984). Also, NMFS has established guidelines for avoiding harassment during whale-watching activities and may establish approach-limit regulations in the future. The other whale species (sei, blue, right, sperm) are not expected to be affected by activities occurring in State waters, or nearshore waters elsewhere, because their typical distribution is farther offshore.

Most recent oil spills in Cook Inlet have not spread beyond the inlet while at potentially harmful concentrations, and thus have remained outside the area usually frequented by the small numbers of fin or humpback whales that enter the proposed sale area. However, the potential for two spills, as well as probable concentration of oil transportation in the lower Cook Inlet and upper Shelikof Strait areas, suggests that some whales are likely to be contacted by a spill; only minor temporary effects (Geraci and St. Aubin, 1985; Geraci, 1990) on a small number of individuals are expected from such contact, resulting in a minimal population effect. No changes in distribution or abundance, mortality, or other potential effects on humpback whales have been related to the EVOS (Baker et al., 1983; Malme et al., 1985).

Entanglement of whales in fishing gear apparently occurs infrequently in most areas. For example, to the extent that they represent the experience of other whale species, <26 percent of stranded gray whales examined show evidence of fisheries interactions (Heyning and Dahlheim, in press; Heyning and Lewis, 1990); NMFS has concluded that gray whale mortality related to fisheries is likely to be insignificant at the present population level, and this may also be true for most of the endangered whales. Subsistence harvest of endangered whales in the vicinity of proposed Sale 149 does not occur. Neither winter-habitat loss nor contamination currently are known to be a significant problem for whale populations.

(2) <u>Steller Sea Lion</u>: If exploration and development/production activities occur on State leases, Steller sea lions could experience disturbance effects similar to those described for the proposed action (Sec. IV.B.1.f). However, State sale areas are confined primarily to areas north of Kachemak and Kamishak Bays, where sea lion sightings are rare, and thus effects from these sales are not expected to substantially increase overall effect on sea lions. However, State Sale 85 proposes to offer leases along Shelikof Strait adjacent to eight sea lion haulout areas (no rookeries) and, because this area has no history of leasing, estimating the level of industrial activity is more speculative than for areas where development has occurred. Although potentially greater numbers of sea lions could encounter activities associated with development on State leases in the Shelikof Strait area than expected for proposed Sale 149, no rookeries or the mortality potentially resulting from their disturbance would be involved. Thus, industry-sea lion interaction associated with State leases is expected to result primarily in the avoidance of a small number of localized foraging or rafting areas and brief behavioral responses to vessels or aircraft encountered in pelagic waters. These sublethal effects are expected to involve <5 percent of the central and western Gulf of Alaska population. Disturbance factors elsewhere in the sea lion range are expected to cause minimal effects on the population.

Most recent oil spills in Cook Inlet have not spread beyond the inlet at detectable concentrations, and thus have remained outside the area where the western Gulf of Alaska sea lion subpopulation is concentrated. An oil spill that contacts a rookery area during the breeding period is expected to cause pup mortality from direct contact, abandonment of pups, and interference with nursing (Calkins and Pitcher, 1982); heavy oiling of a rookery also could interrupt the normal breeding cycle and result in lowered productivity, potentially intensifying the current population decline and requiring more than one generation for recovery (see Sec. IV.B.1.f). A spill contacting only haulout areas or pelagic feeding areas is expected to contact adult and subadult individuals, resulting primarily in sublethal effects.

The potential effect of a second spill, like any other, may vary depending especially on size of spill, season of occurrence, susceptibility of the population, and area of contact. Thus, the overall effect of two spills could range from slight, if both were relatively small and contacted only a few minor haulout areas, to substantially greater than the proposed action, if both contacted rookeries during the breeding season. Given the mean spill number and the probability of one or more spills from a platform, pipeline, and tanker (Appendix B, Table B-1), an intermediate result appears a reasonable assumption where one spill might originate from a platform or pipeline in upper Cook Inlet, and the other from a tanker carrying oil from a Federal lease. In the former, we would expect any oil escaping Cook Inlet to be weathered and dispersed and thus less toxic than fresh oil if it contacts the Barren Islands rookeries, though the mechanical effect resulting in pup hypothermia may be altered little. Oil spilled from a tanker is estimated to contact the Barren Islands but is expected to result in mortality primarily from May to July when pups are present; juveniles contacted might be expected to experience lowered survivorship but, for example, weaned elephant seals and California sea lions contacted by oil did not exhibit increased mortality (Le Boeuf, 1971).

In support of a relatively low expectation of oil-spill effects on sea lions, no changes in distribution, abundance, mortality, pup production, or other potential effects on sea lions have been attributed to the EVOS (Calkins and Becker, 1990; Frost et al., 1993), although the populations' continuing decline may have masked some effects. Further, because the period when the more vulnerable pups are present at rookeries is relatively brief (May-July), a spill appears more likely to contact such an area during the nonbreeding period than during the breeding season. Thus, a reasonable expectation with regard to cumulative oil spills is that their effects are likely to be somewhat greater than described for the base case, potentially requiring more than one generation for recovery to initial population status.

The effect of the incidental catch of sea lions during commercial-fishing operations on the Gulf of Alaska population is unknown (Loughlin and Nelson, 1986) but has decreased since 1985 to perhaps a few hundred individuals per year (55 *FR* 49203, November 26, 1990). Subsistence harvest of sea lions in the Gulf of Alaska is approximately 100 individuals (Haynes and Mishler, 1991; Wolfe and Mishler, 1993), with an unknown effect on the population. Tourist-industry effect on the sea lion population is expected to be minimal, because buffers have been established around rookeries. The population decline that has occurred over the past several decades, its cause unproven but probably food-related, is expected to represent a greater effect on the population than all other cumulative factors combined. Cumulative effect of all factors on the Steller sea lion population is expected to be at least twice as great as the proposed action (at least 2 generations for recovery to initial status), primarily as a result of natural mortality, subsistence harvest, and increased oil-spill risk, although any estimate of severity is confounded by the uncertainty regarding the population decline throughout much of Alaska.

(3) **Short-Tailed Albatross:** Because the short-tailed albatross rarely, if ever, occurs in the vicinity of proposed State leases, no increase in potential overall effect is expected to occur as a result of these cumulative actions. Other factors listed above are not expected to affect the albatross population because of the low probability of interaction.

(4) **Aleutian Canada Goose:** The small Aleutian Canada goose population in the Semidi Islands is not expected to experience adverse effects from proposed State lease sales or Cook Inlet spills because of its distance from the site of these actions. Fishing, tourist-industry, and subsistence activities are not expected to have adverse effects. If continuing progress is made in securing and managing winter and migration habitat, effects on the goose population in these areas is not expected to contribute significantly to the effect. Nor are cumulative factors expected to cause significant losses among the small numbers of geese stopping in the Kodiak area during migration.

(5) **Steller's Eider:** The Steller's eider population, having declined 50 to 75 percent in the past several decades, could be severely affected by any oil spills that contact individuals wintering along the Alaska Peninsula, Kodiak Island, or lower Cook Inlet. Numbers harvested in the vicinity of Barrow, the only remaining breeding area in Alaska, by North Slope residents is not known but could have a significant adverse effect, because harvesting occurs mainly during the breeding season. Evidence for effects of other factors such as pollutants, net entanglement, disease, or variation in food availability also is lacking. The cumulative effect of all factors on the Steller's eider population is expected to be at least twice as great as the proposed action (equivalent to 4 or more generations for recovery to initial status), primarily as a result of natural mortality, subsistence harvest, and increased oil-spill risk, although any estimate of severity is confounded by the uncertainty regarding the recent population decline.

(6) **Peregrine Falcon:** State lease sales and other activities described above are expected to have little effect on peregrine falcon populations. Onshore activities have the greatest potential for adverse effects, but the infrequent occurrence of peregrines in the vicinity of proposed State sale areas suggests that noise and other activities should have only occasional, brief adverse effects on the peregrine falcon. It is improbable that oil spills or fisheries activities would have a significant effect on peregrine populations. Potential effects in areas south of Alaska are expected to be similar to those occurring within the State, although potential habitat loss is unknown. The successful recovery progress exhibited by both peregrine subspecies

breeding in Alaska suggests that the minor increases in potential disturbance from actions listed above are not likely to affect these populations significantly.

(7) **Southern Sea Otter:** The principal sources of cumulative effects to the southern sea otter population are commercial-fishing operations, agricultural runoff and municipal discharges, potential oil spills from tankers carrying Alaskan or imported oil, and potential OCS oil spills.

Apparently, incidental mortality of otters entangled in fishing nets has been reduced significantly through fishing-net restrictions and closures in California (USDOI, MMS, Herndon, 1992). Most of the sea otter range has very low concentrations of environmental pollutants. However, high concentrations of pesticides in agricultural runoff enter Monterey Bay, and municipal and industrial wastes also are discharged into this area from several communities. Adverse effects from contaminants have not been documented in sea otters. They have been found in otter tissues, but at levels generally well below those known to cause debilitation or mortality. Effects of an oil spill have been described under the base-case analysis (Sec. IV.B.1.f); this includes estimated mortality of 23 individuals requiring a recovery period of 1 year at the current population-growth rate. Conditions prevailing at the time of a spill could cause greater mortality requiring up to 5 years (1+ generations) for recovery. However, because the estimated oil volume associated with proposed Sale 149 that potentially would be shipped to Los Angeles, for example, represents only 2.4 percent of the amount already arriving there (a similar proportion also is expected to be shipped to San Francisco), it appears that Sale 149 would contribute only a minor increment of oil-spill risk to the California sea otter population over the current potential risk. Also, the estimated probability of a tanker spill in the potentially affected area is only 6 percent. The effects attributable to Sale 149 oil could vary considerably if the oil were refined in Alaska or shipped to foreign ports (this would require a law change) or if additional spills involving Sale 149 oil occurred in California over the estimated 19-year project period.

(8) **Marbled Murrelet:** The principal sources of cumulative effects to the marbled murrelet population are loss of nesting habitat, commercial-fishing operations (Marshall, 1988), potential oil spills from tankers carrying Alaskan or imported oil, and potential OCS oil spills.

Incidental mortality of murrelets entangled in fishing nets in California is expected to be reduced substantially through fishing-net restrictions and closures emplaced to protect the sea otter (see above); in Washington, losses from this factor may be substantial but as yet not accurately quantified (probably at least in the hundreds of individuals; Marshall, 1988). The effect of an oil spill has been described under the base-case analysis (Sec. IV.B.1.f); this includes estimated mortality of 30 to 144 individuals requiring a recovery period as great as 15 years at the current population replacement rate. However, because the estimated oil volume associated with proposed Sale 149 that potentially would be shipped to San Francisco, for example, represents only 2.4 percent of the amount already arriving there (a similar proportion also is expected to be shipped to Los Angeles), it appears that Sale 149 would contribute only a minor increment of oil-spill risk to the California murrelet population over the current potential cumulative risk. Also, the estimated probability of a tanker spill in the potentially affected area is only 6 percent. The effect attributable to Sale 149 oil could vary considerably if the oil were refined in Alaska or shipped to foreign ports (this would require a law change), or if additional spills involving Sale 149 oil occurred in California over the estimated 19-year project period.

Conclusion: Although disturbance of fin and humpback whales from cumulative sources is expected to result in much more severe adverse behavioral effects than under the proposed action, the overall effect still is not expected to significantly affect distribution, abundance, or survival of their populations. Cumulative disturbance of the other endangered whales is not expected to differ substantially from the proposed action because of their offshore distribution. Minor temporary effects from an additional oil spill are likely to be observed in more individuals than under the proposed action, but population effects still are expected to be minimal. Effects of other cumulative factors on whales are expected to be minimal. Cumulative disturbance effects on Steller sea lions from State oil leases in Shelikof Strait could result in avoidance of several more haulout areas than the proposed action, but still is expected to result in a minor population effect. The effect of the cumulative oil-spill scenario on sea lions is expected to exceed that of the base case somewhat, potentially requiring more than one generation for recovery. Additional cumulative factors other than natural mortality probably would result in mortality of a few hundred individuals per year. Cumulative effect of all factors on the Steller sea lion population, especially factors associated with the recent population decline, is expected to be at least twice as great as the proposed action, requiring substantially more than two generations for recovery. Cumulative effects on the short-tailed albatross and peregrine falcon are expected to be essentially as determined for the proposed action alone. Effects on the Aleutian

Canada goose also would be similar to the proposal, if there is no accelerated loss of winter habitat. Effects on the Steller's eider are expected to be at least double those of the proposed action. Because the estimated oil volume associated with proposed Sale 149 that potentially would be shipped to U.S. Pacific coast ports represents only 2.4 percent of the amount already arriving there, and the estimated probability of a tanker spill in the potentially affected area is only 6 percent, it appears that Sale 149 would contribute only a minor increment of oil-spill risk to the California sea otter or murrelet populations over the current potential cumulative risk.

g. **Effects on Terrestrial Mammals**: The cumulative effects of ongoing and future development as well as the proposal on brown bears, river otters, Sitka black-tailed deer, and other terrestrial mammals are discussed in this section. The following development activities do have actual or could have potential habitat-alteration, oil-spill-environmental degradation, and direct mortality effects on brown bears, river otters, Sitka black-tailed deer, and other terrestrial mammals that reside in the Cook Inlet/Shelikof Strait region.

(1) **Potential Cumulative Effects of Oil and Gas Activities on River Otters, Brown Bears, and Sitka Black-Tailed Deer**: Cumulative oil-industry activities in State waters (25- to 30-year history) include 14 production platforms located 2 to 8 mi offshore in upper Cook Inlet. Existing and proposed State onshore and offshore oil and gas leases in the Cook Inlet/Kenai Peninsula area and proposed in the Cook Inlet/Shelikof Strait region (Table IV.A.7-1) are assumed to increase oil-spill-contact risks to terrestrial mammals and their habitats in the Cook Inlet/Shelikof Strait region. Terrestrial mammal habitats along the coast of the Alaska Peninsula from Puale Bay north to Cape Douglas, Kamishak Bay to Ursus Cove and north to Tuxedni Bay, and Kalgin Island and habitats from the Kenai Peninsula south to Afognak-Shuyak Islands have some chance of oil-spill contact (<0.5-26%) from tanker segments T1 through T8 and pipeline segments T1, T2, and P1 through P5 (see Figs. IV.B.1.g-2,3,4, and IV.B.1.d-1).

The mortality of river otters and brown bears from oil spills associated with the EVOS in Prince William Sound and in the Cook Inlet/Shelikof Strait region has been documented (Faro, Bowyer, and Testa, 1991; Lewis and Sellers, 1991). The recent tanker spill in Prince William Sound killed an unknown number of river otters and at least one brown bear (Faro, Bowyer, and Testa, 1991; Lewis and Sellers, 1991). Sitka black-tailed deer may have eaten oiled kelp in the vicinity of the EVOS, but no serious effects on the deer were found (see Sec. IV.B.1.g).

Under the cumulative case, each of the two assumed 50,000-bbl-oil spills is estimated to result in the loss of fairly small numbers of river otters (perhaps as many as 50), brown bears (perhaps 10), and Sitka black-tailed deer (perhaps 100) directly killed by the spills. Larger numbers of river otters (perhaps 200) and brown bears (perhaps 30) are expected to be sublethally affected by the oil contamination of intertidal habitats and prey (such as mudflats, marshes, and clams). Total recovery of river otters and perhaps brown bears is expected to take >1 year, while the potential loss of Sitka black-tailed deer is expected to be replaced within 1 year. Effects on other terrestrial mammals (such as mink and other furbearers) are expected to last <1 year.

A potential tanker spill (≥100,000 bbl) and smaller oil spills (such as 10,000 bbl) from large fish-processing vessels can kill some river otters (such as 50 otters), depending on the location and season. Such spills could have some long-term (>1 year) effects on portions of the Cook Inlet/Shelikof Strait populations of coastal river otters, if intertidal habitats remain contaminated.

An estimated 123 small oil spills ≥1 and <1,000 bbl also are assumed to occur under the cumulative case (Table IV.A.2-4d). These minor spills are expected to have an additive effect on river otter losses, perhaps increasing losses by 1 to 5 percent and increasing habitat contamination by perhaps 1 to 2 percent.

(2) **Cumulative Effects of Sport Hunting and Nonsport Mortality on Brown Bears**: Brown bear mortalities from human-bear encounters associated with hunting, fishing, and other recreation would be additive to the losses of bears that occurred from the oil spill associated with the proposal. An increase in the intensity of salmon sport fishing and hunting on the Kodiak Wildlife Refuge and adjacent areas, with more people encountering brown bears, is expected to increase the incidental, legal, and illegal sport taking of brown bears in the Kodiak-Afognak Island and Alaska and Kenai Peninsula areas. Liberalized hunting regulations resulting in an increased sport harvest of brown bears could result in a decline in abundance-density of bears without necessarily resulting in an increase in survival of cubs to compensate for such losses (Miller, 1990). Bears that become familiar with people and begin to associate humans with food usually get involved in bear-human encounters, often with subsequent loss of these animals to the population (Warner, 1987).

The increase in human presence and encounters with brown bears associated with timber harvests, sport fishing, and hunting is temporary in nature; however, a long-term increase in human activity and/or the establishment of permanent settlements (project areas, mines, etc.) and construction of access roads into bear habitat usually lead to human-bear conflicts and encounters on a regular basis at dumps, etc., in which bears learn to associate humans with food (Schallenberger, 1980; McLellan 1990). Initially, brown bears will avoid human settlements due to the noise and disturbance (Harding and Nagy, 1980; Kasworm and Manley 1990); but if the area includes an important habitat, such as a salmon stream, the bears are likely to habituate to the noise and, consequently, to human presence. This leads to encounters with humans, who often will not accept the risk of bear attacks; and these encounters too often lead to the loss of bears (Archibald, Ellis, and Hamilton, 1987; McLellan 1990).

Nonsport (human-caused) mortality of brown bears in Alaska increased from 1970 to 1985 and is expected to increase further with development (logging, mining, etc.) and establishment of settlements in remote areas (Miller and Chihuly, 1987). The losses of brown as well as black bears from incidental shootings by people in defense of life and/or property generally have not been significant to bear populations in Alaska as a whole, but such losses contribute to a cumulative decline in bears and in their distribution near cities and villages in Alaska. As human populations in Alaska increase, the numbers of brown bears are expected to decrease, particularly outside of national parks, refuges, and wilderness areas.

(3) Cumulative Noise and Disturbance Effects: Noise and disturbance associated with recreational activities (air, boat, and road traffic and human presence) as well as traffic and increase in humans associated with oil and gas, commercial timber harvests, and other development in terrestrial mammal habitats generally have short-term- (a few minutes to < 1 hour) displacement effects within < 1 mi of the traffic and other human activity. However, long-term displacement or reduced habitat use is expected within about 1 mi of airports, marine harbors, towns, and other development facilities. This disturbance is expected to result in an overall reduction in brown bear distribution on the Kenai Peninsula and on Afognak Island.

(4) Cumulative Effects of Commercial Timber Harvests on Sitka Black-Tailed Deer: The total recent timber harvest on Afognak Island was about 20,000 acres, and the projected harvest is 3,000 acres per year for the next 30 years (Wiedmer, 1993, personal comm.). Two logging camps and an LTF (log-transfer facility) are located in Kazakof Bay on Afognak Island in an important wintering area for Sitka black-tailed deer (Graphic 4). Ongoing and planned timber harvests in the Tongass National Forest in Southeast Alaska and planned timber harvest on Afognak Island adjacent to the proposed lease-sale area have and will result in the removal of old-growth-tree canopy from coastal winter-range habitat of the Sitka black-tailed deer. Old-growth western hemlock-Sitka spruce forests in southeast Alaska are more heavily used by Sitka black-tailed deer than nearby second-growth-forest stands (Wallmo and Schoen, 1980). During severe winters with heavy snow-cover accumulation, the deer use the understory vegetation of old-growth forests as important or critical forage (Hanley and McKendrick, 1985; Yeo and Peek, 1992). Large, dominant trees characteristic of old forests are better able to intercept snowfall than younger, even aged, second-growth trees and provide forage access for the deer, even during years of heavy snowfall (Kirchhoff and Schoen, 1985). The burial of shrubs by snow affects the availability of winter forage to black-tailed deer, even when prewinter shrub heights exceed the mean snow depth (Hovey and Harestad, 1992).

The depletion of high-volume, old-growth-forest stands by commercial logging is expected to adversely affect deer on winter range subject to periodic, deep snowfall (Kirchhoff and Schoen, 1985). The loss of old-growth-timber canopy on Afognak Island from proposed timber harvests is likely to have less of an effect on the availability of winter forage for deer on Afognak Island than timber harvests in Southeast Alaska because of the shallower snow depth in the Kodiak-Afognak Islands area (a mean depth of 21 in in the city of Kodiak and 9 in in Larsen Bay) in comparison to Southeast Alaska (60 in or more) (Brower et al., 1988). However, the removal of large areas (20,000 acres and 3,000 acres per year) of forest canopy from Afognak Island is expected to reduce the availability of winter forage of Sitka black-tailed deer during winters of heavy snowfall and contribute to the population declines that occur during these years. This effect is expected to persist for several years.

(5) Cumulative Effects of Commercial Timber Harvest and Other Coastal Development on Brown Bears: The total recent timber harvest on Afognak Island was about 20,000 acres and the projected harvest is 3,000 acres per year for the next 30 years (Wiedmer, 1993, personal comm.). Two logging camps and an LTF are located in Kazakof Bay on Afognak Island in an important spring habitat for brown bears (see Graphic 4).

Old-growth forest-riparian habitat in Southeast as well as Southcentral Alaska adjacent to the proposed sale area is important habitat for brown bears (Schoen and Beier, 1990). Old-growth-timber harvests that degrade salmon streams would adversely affect brown bears; and the construction of access roads into the forests is expected to increase human access to brown bears and increase both sport harvest of the bears and incidental mortality of bears in the project areas (Schoen and Beier, 1990; Titus and Beier, 1992). Logging roads that have been constructed and others that will be constructed for timber harvest on Afognak Island generally are open to the public when logging operations are not occurring and when operations are complete. This increased access by the public is expected to increase human-bear encounters and increase the mortality of brown bears on Afognak Island, leading to a population decline (perhaps 1)%); this effect is expected to last for more than one generation.

The increase in public access (construction of roads and powerlines) and incentive to develop rural lands near the Terror Lake Hydroelectric Project is expected to have a long-term local effect on Kodiak brown bears through increased disturbance and losses of bears to recreationists and settlers (Smith and Van Dalle, 1990).

__Summary:__ Habitat alteration associated with timber harvest and other onshore development is expected to have long-term (>1 to several generations) effects on the availability of winter forage of Sitka black-tailed deer on Afognak Island and is expected to increase human access to brown bear habitats, leading to an increase in bear mortality (perhaps by 10%) and an overall reduction in brown bear distribution on the Kenai Peninsula and Afognak Island. Noise and disturbance associated with cumulative air, boat, and road traffic is expected to have short-term- (a few minutes to <1 hour) displacement effects and local (within 1 mi) long-term- (>1 to several generations) displacement effects on terrestrial mammals, especially brown bears near development facilities (this effect is directly related to human-bear encounters). Each of the two assumed 50,000-bbl-oil spills is expected to result in the loss of fairly small numbers of river otters (perhaps as many as 100), brown bears (10), and Sitka black-tailed deer (perhaps 100) directly killed by the spills. Larger numbers of river otters (perhaps 200) and brown bears (perhaps 30) are expected to be sublethally affected by the oil contamination of intertidal habitats and prey (such as mudflats, salt marshes, and clams). Total recovery of river otters and perhaps brown bears is expected to take >1 year, while the potential loss of Sitka black-tailed deer is expected to be replaced within 1 year.

The regional populations of river otters, brown bears, Sitka black-tailed deer, and other terrestrial mammals are not expected to be affected by cumulative oil spills. However, cumulative onshore development is expected to have a long-term (>1 generation) effect on the distribution and abundance of brown bears. The overall contribution of exploration and development activities associated with the proposal is not expected to affect regional populations of terrestrial mammals.

__Conclusion:__ The overall cumulative effect on terrestrial mammals is expected to be reduced distribution and reduced abundance of brown bears and, to a lesser extent, reduced numbers of river otters due to oil-spill losses (perhaps as many as 100 otters), reduced number of brown bears due to oil-spill losses (perhaps 30), and the loss of a number of black-tailed deer (perhaps as many as 100) from oil spills and reduced productivity from forest-habitat loss. Total recovery is expected to take several generations. The contribution of the proposal to the cumulative case is expected to be :0 percent or less of the mortality, <1 percent of the habitat loss, and no effect on regional populations of terrestrial mammals.

h. __Effects on the Economy:__ In the cumulative case, employment from the major projects described in Table IV.A.7-1 is anticipated to increase at an annual rate of 1 percent per year. An increase in employment of 1 percent per year is projected in a report by the University of Alaska, Institute for Social and Economic Research (1992). These employment projections in the ISER report assume approximately the same range of projects and factors affecting the economy as are described in Table IV.A.7-1. This 1-percent-annual increase in employment, plus the increase of zero to 3 percent for <5 years as a result of the base-case activity, results in an annual increase of 1 to 4 percent for <5 years and a 1-percent-annual increase for another 15 years. This change in employment translates to a change of 4 percent in average income, <6 percent in cost of living, <3 percent in property taxes, and <5 percent in sales taxes on the western side of the Kenai Peninsula annually for <5 years and a 1-percent-annual increase for another 15 years.

Increased employment is the most significant economic effect generated by the base case. Employees would work on the construction, operation, and servicing of facilities associated with the sale. These facilities are described in the exploration and development schedule for the base case.

Under the base case, property-tax revenue of $2.2 million for the KPB and $0.4 million for the State (1993 dollars) would be added annually after the year 2002. For the cumulative case, property-tax revenue would increase at a rate of 1 percent annually plus $2.2 million for the KPB and $0.4 million for the State (1993 dollars) annually after the year 2002. Headquarters employment for the base case is assumed to be located in Anchorage. This would be a <1-percent increase in employment for Anchorage for any given year. For the base case, the economic effects of oil spills <1,000 bbl would be very minimal. These small spills would be cleaned up by CISPRI or some similar organization. A spill < 1,000 bbl would require less than 50 person hours to clean up.

The most relevant historical experience in Alaskan waters of a tanker spill of 109,000 bbl (average tanker-size spill, Sec. IV.A.2.a(4)) is the EVOS of 1989, which spilled 240,000 bbl. This spill generated enormous employment that rose to the level of 10,000 workers directly doing cleanup work in relatively remote locations. Smaller numbers of cleanup workers returned in the warmer months each year following 1989 until 1992. Numerous local residents quit their jobs to work on the cleanup at often significantly higher wages. This generated a sudden and significant inflation in the local economy (Cohen, 1993). Anecdotal information indicates that housing rents in Valdez in 1989 increased from 25 percent in some cases to sixfold in others, and inflated rents continued into 1990. Prices of food and other goods increased only slightly (Henning, 1993, personal comm.).

The number of cleanup workers actually used for a spill associated with Sale 149 would depend to a great extent on what procedures are called for in the oil-spill-contingency plan, how well prepared with equipment and training the entities responsible for cleanup are, how efficiently the cleanup is executed, and how well in reality the coordination of cleanup among numerous responsible entities is executed. A spill resulting from activity associated with Sale 149 could generate half the workers associated with the EVOS, or 5,000 cleanup workers.

In the base case, a large oil spill would generate 5,000 cleanup jobs for 6 months in the first year, declining to zero by the fourth year following the spill. During cleanup of a large spill, local labor supplies could be deleted and local businesses could find themselves without workers or having to increase salaries and prices to compete for limited labor. This wage inflation should be short-term, <1 year in duration. Based upon the *Exxon Valdez* cleanup, some fishing boats and crews may secure contracts involved in the cleanup operation. Local communities would experience a doubling of housing rents for 1 year.

Conclusion: The cumulative case, including routine OCS activity, would generate increases only slightly greater than the base case. These increases would be of between 1- and 4-percent in resident employment, <6 percent in cost of living, <3 percent in property tax, and <5 percent in sales tax on the western side of the Kenai Peninsula annually for <5 years and 1 percent for another 15 years. Property tax would increase $2.2 million for the KPB and $0.4 million for the State (in 1993 dollars) annually after the year 2002. A large oil spill would generate 5,000 cleanup jobs for 6 months in the first year, declining to zero by the fourth year following the spill. A short-term labor shortage and wage inflation could occur, but for <1 year in duration. Local communities would experience a doubling of housing rents for 1 year.

i. **Effects on Commercial Fisheries:** In addition to the base-case proposal, other activities associated with the cumulative case that may affect the Cook Inlet commercial-fishing industry include the following: State oil and gas lease sales (Sales 78 and 85); State oil and gas fields (Granite Point, Trading Bay, McArthur River, Middle Ground Shoal, Swanson River, and Beaver Creek); oil and gas transportation (Drift River Oil Terminal, Alaska North Slope crude, and import tankering); noncrude carriers; and discharges from the Port of Anchorage. Nearby lumbering operations and wastewater discharges associated with these activities within the sale area are not expected to have a measurable effect the Cook Inlet commercial-fishing industry.

Activities associated with these projects that could affect the Cook Inlet commercial-fishing industry are the same as discussed for the base case in Section IV.B.1.i. (i.e., drilling discharges, offshore construction, seismic surveys, and oil spills), although they would be more numerous because of the additional State activities. Drilling discharges from all sources in the cumulative case are not expected to affect commercial fishing, due to the limited area affected near the platform-discharge point. Offshore construction, platforms, and pipelines, are expected to result in space-use conflicts in the cumulative case (e.g., competition for docking space or gear loss); however they are expected to be relatively few in number and minor in scope. Seismic surveys, planned and coordinated with the commercial-fishing industry, are expected to have a minimal effect on the Cook Inlet commercial-fishing industry.

The effects of a large oil spill (50,000 bbl) and 49 small spills (555 bbl) were discussed in the base-case analysis. However, the cumulative case assumes the occurrence of two 50,000-bbl-oil spills and 123 small spills (1,385 bbl). The effects of the two large spills on the Cook Inlet commercial-fishing industry are expected to be essentially double those discussed for the 50,000-bbl base-case spill, and they are summarized below. Due to the relatively small amount of oil involved, small oil spills estimated for the cumulative case are not expected to result in a measurable economic loss due to closures or reduced market values. Hence, they are not expected to have a measurable economic effect on the Cook Inlet commercial-fishing industry.

The estimated effect of the two large (50,000-bbl) oil spills on the Cook Inlet commercial-fishing industry is based on what occurred during the *Exxon Valdez* and *Glacier Bay* spills, and primarily depends on the highly variable EVOS cost estimates (ranging from $9 to $43 million/year for 2 years). From 1983 to 1993 the value of the Cook Inlet commercial fishery appears to have ranged between about $50 and $135 million/year. Based on the above, in any 2-year period when the value of the Cook Inlet commercial fishery is estimated to be about $50 million/year, a 2-year loss of about $9 million/year represents an 18-percent/year loss for 2 years; whereas a 2-year loss of about $43 million/year represents an 86-percent/year loss for 2 years. In a 2-year period when the value of the Cook Inlet commercial fishery is estimated to be closer to $135 million/year, a 2-year loss of about $9 million/year represents a 7-percent/year loss for 2 years; whereas a 2-year loss of $43 million/year represents a 32-percent/year loss for 2 years.

Because the occurrence of a large oil spill would preclude any knowledge of what the commercial fishery would have been worth, the value of the commercial fishery at the time of the assumed 50,000-bbl-oil spill is assumed to be the average annual value (1983-1993) of the Cook Inlet commercial fishery. In terms of this value (about 65 million), a 2-year loss of 14 to 66 percent/year of the annual fishery value is more likely. Thus, each of the two spills assumed for the cumulative case are estimated to result in a 2-year loss of about 15 to 65 percent/year to the Cook Inlet commercial-fishing industry. Estimated losses to the Kodiak commercial-fishing industry are expected to be less than half of those estimated for Cook Inlet, or about 5 to 25 percent/year for 2 years following the assumed large Cook Inlet oil spill. This amounts to an estimated loss of about $4 to $19 million/year to the Kodiak commercial-fishing industry. Thus, each of the two spills assumed for the cumulative case also is estimated to result in a 2-year loss of about 5 to 25 percent/year to the Kodiak commercial-fishing industry. However, the EVOS experience has demonstrated that compensation to the commercial-fishing industry for participating in the cleanup of a large Cook Inlet oil spill is likely to exceed these economic losses by several orders of magnitude.

Conclusion: Based on the assumptions discussed in the text (e.g., a 50,000-bbl spill occurs during the commercial-fishing season), EVOS-loss estimates, and the average annual value of the Cook Inlet commercial fishery, the cumulative case is estimated to result in economic losses to the Cook Inlet commercial-fishing industry ranging from about 15 to 65 percent/year, for 2 years following each of the assumed 50,000-bbl-oil spills. Losses to the Kodiak commercial-fishing industry from the same spills are estimated to range from about 5 to 25 percent/year, for 2 years following each of these assumed oil spills.

j. Effects on Subsistence-Harvest Patterns: Effects on subsistence-harvest patterns in the cumulative case are assessed in terms of renewable resource development, including commercialization of fish resources and logging; nonrenewable resource development, such as existing and proposed State and Federal oil and gas production and transportation; and increased urbanization and community development, including population growth, land consumption, improved transportation, and tourism. All ongoing and planned projects as described in Table IV.A.7-1 are assumed to reach full implementation and development.

(1) Renewable-Resource Development: Commercial fishing for salmon, halibut, and shellfish; guided sportfishing resident and nonresident sportfishing; and personal-use fisheries in the aggregate have produced intense competition for the allocation of fisheries resources in the Cook Inlet/Kenai Peninsula area. The Kenai Peninsula is the sportfishing destination of choice for Anchorage residents and attracts nonresidents for personal and guided sportfishing in fresh- and saltwater environments. This commercialization of fish resources has greatly affected subsistence fishing in the past, as shown by the past experience of Tyonek residents with subsistence king salmon fishing (prohibited between 1964 and 1980; see Fall, Foster, and Stanek, 1984) and the more recent court-ordered subsistence fisheries for other traditional communities (Wong, 1993). Subsistence fishing returned to the Kenaitze of the Kenai Peninsula by court order in 1989 with an "educational" setnet fishery established by the State near the mouth of the Kenai River. Similar fisheries were established by the State as a result of a court order in 1993 for Knik, Eklutna, and Ninilchik (Wong, 1993). These limited-catch fisheries require residents to petition the State annually for permit renewal, implying that such fisheries can be terminated (Wong, 1993). The need for constant vigil to maintain the means for transmitting cultural traditions through subsistence-net fishing is not a comfortable role for residents of traditional communities.

Kodiak Island and Alaska Peninsula communities have not been subject to similar pressures on subsistence harvests because of their relative isolation, although sports hunting and fishing pressures exist. In addition, the existing and proposed logging on Afognak Island (by the Afognak Native Corporation) and the barge/log-transfer ports at Danger (Kazakof) Bay could increase resource vulnerability to oil spills because of habitat destruction and contamination brought about by logging. Subsistence harvests by the communities of Ouzinkie and Port Lions could be reduced because of this, because both communities use Afognak Island for subsistence purposes.

Hunting patterns in Tyonek were changed in the past with the advent of logging and land clearing within their traditional hunting areas (see Fall, Foster, and Stanek, 1984). Land clearance for homesteading/farming purposes also has influenced animal distribution patterns on the Kenai Peninsula and elsewhere where practiced. This should be true as well for logging on the Kenai Peninsula by the Seldovia Native Association and the Chugach Alaska Corporation, although it is unclear what communities might be affected.

(2) <u>Nonrenewable-Resource Development</u>: Oil and gas fields and related production and transportation facilities in Cook Inlet and on the Kenai Peninsula are listed on Table IV.A-7-1. This production and transportation infrastructure has contributed in different measure to past effects on subsistence-harvest patterns within the Cook Inlet area, which should continue in the future. Existing oil and gas fields and ancillary roads and pipelines have displaced wildlife habitat, and disposal sites are claimed to have contaminated groundwater supplies in selected areas (see The Public Awareness Committee for the Environment, 1991). Proposed State oil and gas Lease Sales 78 and 85 will offer considerably more acreage of submerged and onshore lands in the Cook Inlet/Shelikof Strait area, increasing the risk to subsistence resources.

<u>Oil Spills from OCS and State of Alaska Oil Production and Transportation</u>: Pervasive throughout the Cook Inlet/Shelikof Strait area is the experience communities had with the 1989 *Exxon Valdez* spill. Subsistence-harvest patterns of communities were changed radically because of fear of contamination, limited time available for harvest, and other reasons (see Sec. III.C.3.d for a discussion of the effects of the EVOS on subsistence). Total subsistence harvests declined 50 to almost 80 percent in several communities the first year after the spill. Some resources have not returned or are not considered useable for human consumption several years after the spill. For example, some subsistence resources used in Nanwalek, such as chitons and mussels, had not returned years after the spill, and people were still concerned over the health risks of eating contaminated subsistence resources (Kvasnikoff, 1992, personal comm.). For this reason, Nanwalek residents are having to travel across Kachemak Bay to harvest clams and other intertidal resources (Andrews, 1993, personal comm.).

An assumed spill of 50,000 bbl in lower Cook Inlet would affect subsistence-harvest patterns on the southern part of the Kenai Peninsula, especially the communities of Nanwalek and Port Graham (see Sec. IV.C.1.j). Combined with the EVOS experience, it would be expected that residents again would be fearful of contamination of subsistence resources and, in the short-term, would have highly reduced harvests as a result. Harvests would be reduced due to reduced availability, accessibility, or utility of subsistence resources for the affected community or communities. Different harvest strategies would have to be employed to take the harvest disruption into account, which could include harvest relocation (if suitable alternative sites existed) or the substitution of other available resources. Based on the EVOS experience, a 50,000-bbl spill, which is roughly 20 percent of the EVOS, would be expected to produce harvest-level reductions estimated at 30 to 50 percent of average annual yields in the first year for the most severely affected communities, with harvest levels for most resources rebounding during the next 2 to 3 years.

(3) <u>Urbanization and Community Development</u>: Southcentral Alaska has experienced extensive growth pressures from economic development throughout the State, especially from growth in the oil and gas industry. Kodiak Island has not been directly subjected to such industrial pressures, relying more on the commercialization of renewable resources for economic stimulus, but it has benefitted indirectly through State subventions and capital projects. On the Kenai Peninsula, the oil and gas industry in conjunction with improved surface transportation established a powerful economic force that produced increased levels of urbanization and land development and introduced an urbanized population.

Habitat reduction, increased local population pressure, and increased numbers of recreational and tourism resources users combined as factors to regulate out many traditional subsistence practices.

Except for specific Alaskan Native groups, the outlook on subsistence in the Cook Inlet area largely has been reduced to an urban perspective (enjoying the outdoors and filling the freezer) over the last several decades. Communities such as Tyonek, Nanwalek, and Port Graham have been able to maintain ties with a subsistence-based culture because of their relative isolation in the area, whereas other groups, such as the Kenaitze, have been unable to avoid the industrialization of land and resources and have become engulfed in the process. As pointed out earlier, subsistence fishing returned to the Kenaitze by court order in 1989 with an "educational" setnet fishery near the mouth of the Kenai River. Similar fisheries were established by court order in 1993 for Knik, Eklutna, and Ninilchik (Wong, 1993). Many non-Native Alaskans living in the Homer/Kachemak Bay area make fairly wide use of available subsistence resources, but this is more in the homesteader tradition of self-sufficiency than a deeper cultural meaning.

Summary: Subsistence-harvest patterns have changed considerably over time within the Cook Inlet/Shelikof Strait area as a result of the commercial use of renewable and nonrenewable resources and the population growth and land development these activities have produced and are estimated to produce in the future. The relatively isolated communities on Kodiak Island and the Alaska Peninsula have been able to maintain traditional subsistence practices, although both areas are subjected to sports hunting and fishing pressures. Subsistence harvests on Afognak Island would be reduced if logging operations reduced or contaminated resource habitat. Harvest levels for Kodiak Island and Alaska Peninsula communities likely also would be reduced over the life of the lease-sale proposal.

Cook Inlet communities, such as Tyonek, Nanwalek, and Port Graham, also have had the advantage of relative isolation from the pressures of urban development, although their subsistence-fisheries harvests have been changed by regulations focused on the needs of the resources and other users. Land clearance and logging have changed the subsistence-harvest patterns for these and other communities, some of which have been engulfed by the onrushing tide of urban development, stimulated in large part by the development of the oil and gas industry offshore in Cook Inlet and on the adjoining Kenai Peninsula. Increased use of the oil and gas infrastructure on the peninsula as a result of existing and proposed State oil and gas lease sales and the Sale 149 proposal should not disrupt subsistence harvests in those Cook Inlet communities where such practices have significance, except in the event of a large oil spill. The 50,000-bbl spill estimated to occur in Cook Inlet under the cumulative case would reduce subsistence harvests and/or require the need to relocate harvest sites, if available, for Tyonek, Nanwalek, or Port Graham, depending on the location of the spill. For both lower Cook Inlet and Kodiak Island communities, a 50,000-bbl spill, which is roughly 20 percent of the EVOS, would be expected to produce harvest-level reductions estimated at 30 to 50 percent of average annual yields in the first year for the most severely affected communities, with harvest levels for most resources rebounding during the next 2 to 3 years.

Conclusion: Subsistence harvests in the cumulative case would be expected to undergo continuing disruptions and periodic reductions over time and be reduced by as much as 50 percent at some points in time in one or more Kodiak Island and lower Cook Inlet communities for at least 1 year and to a lesser extent for selected resources 2 to 3 years beyond; effects are caused by one or more large (≥1,000-bbl) accidental oil spills that have a 64-percent chance of occurring. The base case contributes primarily to effects in lower Cook Inlet communities.

k. Effects on Sociocultural Systems: Effects on sociocultural systems in the cumulative case are assessed in terms of (1) current conditions, described in Section III.C.4; (2) effects from the proposal described in Section IV.B.1.k; and (3) effects from the projects described in Table IV.A.7-1. Table IV.A.2-2 shows oil-spill-occurrence estimates and probabilities of one or more spills ≥1,000 bbl resulting from Federal and State oil production and tankering in the cumulative case. Analysis of effects on sociocultural systems takes into account effects from (1) prelease and postlease planning processes, (2) the introduction of industrial activities and changes in industrial activities and community population levels, (3) changes in subsistence-harvest patterns, (4) changes resulting from accidental spills and postspill-cleanup events, and (5) changes in other aspects of the economy. The proposed projects shown on Table IV.A.7-1 are assumed to be fully implemented.

(1) Changes Resulting from Planning Processes: Effects on sociocultural systems begin with the prelease processes of announcing the proposed sale and carrying out the preparation of an EIS. Given a significant oil discovery, planning processes are again engaged to prepare a developmental EIS.

Each of these sometimes lengthy processes carried out in various ways by Federal and State governments causes stress and anxiety among affected publics. The discussion under the base case (Sec. IV.B.1.k.) explores the types of impacts involved.

(2) **Changes in Industrial Activities and Population Levels:** The resident population associated with the proposal and proposed State oil and gas projects are expected to be situated on the Kenai Peninsula because of the location of the projects and the existence of an extensive oil- and gas-support infrastructure in the central part of the peninsula. The character of the population involved is also expected to be compatible with the character of the central Kenai Peninsula community due to the size of the oil and gas industry there. Establishment of new oil or gas fields on State lands in the Kachemak Bay/Homer area would introduce a new group to the existing fishing/farming/tourism character of the place, which could lead to periodic conflict over time and would certainly do so if a large oil spill were involved.

(3) **Changes in Subsistence-Harvest Patterns:** Proposed State oil and gas projects and Federal offshore lease sales (the proposal) are oriented to the Cook Inlet area, where effects on sociocultural systems from changes in subsistence harvests would be focused on the southern part of the Kenai Peninsula because of the use of the Kenai Peninsula oil and gas infrastructure and the need to transport crude or refined product to market with tankers. Most likely, the Kachemak Bay communities of Nanwalek and Port Graham would be most affected (see Sec. IV.B.12.j).

As discussed in Section III.C.3.e, research carried out for 3 study years following the EVOS (a much larger spill than used here for analysis purposes) showed that subsistence harvests in Nanwalek and Port Graham had largely returned to "normal" levels in study years 1992/93 and 1993/94 (Fall and Utermohle, 1995). Confidence in the edible quality of wild foods increased each year following the spill. The composition of the post-spill subsistence harvests showed considerable consistency despite the dramatic impact of the EVOS.

Logging carried out on the Kenai Peninsula by the Seldovia Native Association and the Chugach Alaska Corporation additionally could contribute to social stress from subsistence-resource contamination from logging, but it is unclear just what communities might be affected. Disruptions of a lesser extent are estimated to be realized in Ouzinkie and Port Lions because of their use of Afognak Island for subsistence harvests. Although the harvest area for these communities is considered large enough not to be contacted simultaneously by a spill, the logging considered possible on Afognak Island (by the Afognak Native Corporation) and the barge/log-transfer ports at Danger (Kazakof) Bay in the cumulative case could increase resource vulnerability to oil spills because of habitat destruction and contamination brought on by logging.

(4) **Changes Resulting from Accidental Spills and Postspill-Cleanup Events:** There is an 64-percent chance of one or more oil spills ≥1,000 bbl occurring in the cumulative case. For purposes of analysis, two 50,000-bbl oil spills are assumed to occur (not simultaneously) in Cook Inlet. A spill of this size is approximately 20 percent the size of the EVOS. Effects on sociocultural systems from accidental oil spills and cleanup efforts from State oil and gas projects and Federal oil and gas leases (the proposal) would be centered directly on southern Kenai Peninsula communities and indirectly on several Kodiak Island communities.

Individual and social stress and anxiety levels would be expected to increase in the one or more communities that use the southern part of the Kenai Peninsula for subsistence harvests because of the loss of subsistence resources, contamination of habitat, fear of the health effects of eating contaminated wild foods, and the need to depend on the knowledge of others about environmental contamination. The organization of subsistence activities among kinship and friendship groups and the relationships among those that customarily process and share subsistence harvests also would be modified and could decline in importance. Stress-induced increases in alcohol and drug abuse would produce increases in numerous substance-abuse problems, such as child abuse, domestic violence, and accidents. The duration of individual and social effects would depend on the severity of the oil-spill experience. Institutionally, communities would undergo considerable disruption and community conflict, with litigation constituting a secondary source of postspill social and community stress. Beyond the southern part of the Kenai Peninsula, indirect sociocultural effects would be expected throughout Southcentral Alaska, and especially on Kodiak Island and in the Chignik area of the Alaska Peninsula, in the form of increased stress and anxiety over matters such as the plight of family and friends, the possibility of tainted subsistence resources, and the potential loss of income from fouled or failed fisheries.

Just as important as determining potential social impacts from proposed Federal and State offshore sales is understanding the context of such effects in lower Cook Inlet communities, where the social residue from the much larger EVOS remains. As discussed in Section III.C.4.d(1), research carried out for 3 study years following the EVOS showed that children in Nanwalek and Port Graham had vastly less participation in subsistence activities because of the EVOS, especially in Nanwalek, where a high percentage (87.5%) of adults worked in cleanup jobs in 1989—jobs that often kept workers from the community for extended periods. In turn, children were not able to engage in their normal pattern of subsistence activities accompanied by their parents.

Sharing of wild foods also changed in Nanwalek and Port Graham. Two years following the spill, Nanwalek and Port Graham respondents reported less sharing in the community than before the spill (48.1% in Nanwalek and 32.6% in Port Graham). In the third year, there was an even larger number of respondents reporting less sharing, explained in part by Nanwalek respondents because of having more equipment (purchased with cleanup income?) to gather resources on their own.

The larger context, of course, in evaluating potential cumulative impacts from oil spills lies in the beliefs about the extent of damage that would be caused to wild foods and the human condition in these communities. In the research, Nanwalek respondents echoed their concern about offshore oil and gas development expressed in the 1980's, with Port Graham residents equally disturbed. Actually, these concerns go back to the 1970's, probably evolving from the State Lease Sale 28 in Kachemak Bay in 1973 and the forced buyback of leases in 1977 because of the resulting public outcry. In that same year (1977), the English Bay (Nanwalek) Corporation filed suit against the Federal offshore sale CI. Following the sale, the suit was resumed. A settlement was entered in this case for amicable resolution of the suit and the case was dismissed in March 1978, subject to compliance by the USDOI with the settlement agreement (USDOI, 1981). Individuals and communities in lower Cook Inlet probably are not healed psychologically and socially from the EVOS, because memories of this epic experience can last for decades. The point here is that although the EVOS certainly reinforced local fears in very concrete terms, these fears and the stress and anxiety they created existed prior to the EVOS and may never be healed.

(5) <u>Changes in Other Aspects of the Economy</u>: Changes in other aspects of the southcentral Alaska economy over the life of the proposed action obviously would change conditions of the sociocultural systems existing there, although it is unlikely that major changes would take place in cultural orientations or other social institutions. Disruptions in existing sectors of the economy, such as commercial fishing, commercial sport-fishing, tourism, logging, or agriculture, would tend to disrupt and produce stressful relations within families and within local public institutions. The introduction of projects not considered on Table IV.A.7-1, such as additional industries or the construction of major new public facilities, additionally would produce changes in social conditions to an unknown extent.

<u>Summary</u>: Effects on sociocultural systems in the cumulative case are centered primarily on southern Kenai Peninsula communities, including the Alutiiq communities of Nanwalek and Port Graham and, to a lesser extent, on the communities on Kodiak Island and the Alaska Peninsula because of increased oil-facility construction and operation, oil spills, and logging. In the oil and gas sector, the prelease process of announcing proposed State and Federal sales and carrying out the preparation of studies and environmental documents initiates the onset of concerns by affected publics. Given a significant oil discovery, planning processes are again engaged to prepare developmental environmental documents. Based on the scenario data used here for the purposes of analysis in the cumulative case, individual and social stress and anxiety levels would be expected to increase over the loss of subsistence resources, contamination of habitat, fear of the health effects of eating contaminated wild foods, and the need to depend on the knowledge of others about environmental contamination. In the Alutiiq communities, the organization of subsistence activities among kinship and friendship groups and the relationships among those that customarily process and share subsistence harvests would be modified or decline in importance. Stress-induced increases in alcohol and drug abuse would produce increases in numerous substance-abuse problems, such a child abuse, domestic violence, and accidents. Communities would be expected to undergo considerable disruption and experience community conflict, with litigation constituting a secondary source of postspill social and community stress. Individual, social, and institutional effects would be expected to last for several years in each instance and in some cases endure in memory for decades. Individuals and communities experiencing continued stress from the EVOS may never be relieved of such fears, since they most likely predate the EVOS by several decades. Seasonal and cyclical changes and disruptions in other sectors of the economy also would produce changes in sociocultural systems over time, although major changes in cultural orientations or social institutions would not be expected.

Conclusion: Sociocultural systems in the cumulative case would experience seasonal and cyclical change over time and undergo periodic episodes of increased individual, social, and institutional stress and disruption in one or more southern Kenai Peninsula and Kodiak Island communities that could last for several years in each instance and in some cases endure in memory for decades; effects are caused by both prelease and potential postlease processes and events. The base case contributes primarily to effects on Kenai Peninsula communities.

l. **Effects on Archaeological and Cultural Resources:** Exploration, development and production, and crude-oil transportation activities in the OCS planning areas of Cook Inlet/Shelikof Strait plus State and civilian commercial activities would make a cumulative effect higher than the base case. Possible spills resulting from Federal oil and gas production would be in accordance with the base-case transportation and exploration scenario. Production from Granite Point, Trading Bay, and McArthur River fields is piped ashore then piped to the Drift River Facility and tankered south to the U.S. west coast. The Middle Ground Shoal field is piped ashore and then piped to the Nikiski industrial complex. Alaska North Slope crude oil is tankered from Valdez to Nikiski. Very infrequent shipments of crude oil from Australia, South America, and Indonesia are made to Nikiski through the Cook Inlet sale area. Spills from such activity could affect archaeological and cultural resources to the same degree and would be additive to those stated in the base case. That is, the activities of Federal cleanup operations would disturb ≤3 percent of the resources in those areas contacted by the spill.

State of Alaska exploration and production in Cook Inlet and civilian commercial activities also would have an effect on archaeological resources, if there were spills. The effects would be similar and additive to those of the base case. Increased population due to work on any one of the wells or facilities could have some effects, either by accidental spills or by visitation, on archaeological sites. Two State lease sales (Sales 78 and 85) would have some activity that would affect resources near them or be related to the transportation of oil. Five existing oil and gas fields have activities that could cause oil-transportation spills at some time. The Port of Anchorage has vessels moving through Cook Inlet that could be the source of small spills. Military training exercises and commercial-fishing and logging operations also would be sources of small spills. Construction activities related to these activities also could disturb resources, if surveys and mitigation are not used to protect the resources. The construction of ferry terminals, small-boat harbors, coal-industry terminals, and new State oil terminals and other water-related facilities could be the sources of disturbance to resources (refer to Table IV.A.7-1 for details on sources of cumulative effects). These sources would disturb resources close to the facilities constructed except in the case of transportation and support-vehicle gas and oil spills during construction. Such spills and the construction activities are expected to add another 1 percent to the disturbance of archaeological resources at the same land segments analyzed for the base case.

Conclusion: The cumulative effects of other than Federal activities would be additive to the base case and would amount to a total disturbance of 5 percent of all the resources. Oil-spill disturbance would amount to 1 to 3 percent of the archaeological and cultural resources for each particular area contacted by a spill.

m. **Effects on National and State Parks and Related Recreational Places:** Exploration, development and production, and crude-oil transportation activities in the OCS planning areas of Cook Inlet/Shelikof Strait plus State and civilian commercial activities would make a cumulative effect higher than the base case. Major cumulative-case projects that may affect these resources are described in detail in Section IV.A. Possible spills resulting from Federal oil and gas production would be in accordance with the base-case transportation and exploration scenario (Table IV.A.2-2). The risk of effects from State spills would be greater than the risk resulting from the Federal scenario, because the projects are closer to shore than the Federal projects. That is, production from the Granite Point, Trading Bay, and McArthur River fields is piped ashore, piped onshore to the Drift River Facility, and tankered south to the U.S. west coast. The Middle Ground Shoal field is piped ashore and then piped onshore to the Nikiski industrial complex. Alaska North Slope crude oil is tankered from Valdez to Nikiski. Very infrequent shipments of crude oil from Australia, South America, and Indonesia are made to Nikiski through the Cook Inlet sale area. Spills from such activity may affect national and State parks and related recreational places.

State of Alaska exploration and production in Cook Inlet also would have an effect on resources of national and State parks and related recreational places, if spills occurred. Increased population due to work on any one of the wells or facilities could have some effects, either by accidental spills or by visitation, on archaeological resources. The effects of the spills, cleanup activities, and operational activities would be similar in type and magnitude to Federal spills analyzed in this EIS. Two State lease sales (Sales 78 and 85) would have some activity that would affect resources near them or be related to the transportation of oil. Five existing oil and gas fields have activities that could cause oil-transportation spills at some time. The Port of Anchorage has vessels moving through Cook Inlet that could be the source of small spills. Military training exercises, and commercial-fishing and -logging operations also would be sources of small spills. Construction activities related to these activities also could disturb resources, if surveys and mitigation are not used to protect the resources. The construction of ferry terminals, small-boat harbors, coal-industry terminals, and new State oil terminals and other water-related facilities could be the sources of disturbance to resources (refer to Table IV.A.7-1 for details on sources of cumulative effects). These sources would disturb resources close to the facilities constructed except in the case of transportation and support-vehicle gas and oil spills during construction. Such spills and the construction activities are expected to add another 1 percent to the disturbance of the resources at the same land segments analyzed for the base case. Total disturbance of all resources by activities attributable to the base case is expected to be >3 percent.

Any closure of water-oriented recreational facilities would be only for short periods due to cleanup of small oil spills. In particular, trends for visitors to national parks and refuges would show a slight loss during the year after a spill (Fig. III.C.6-2) in spite of industrial support of extensive advertising in other States to bring tourists to Alaska. These rates would continue to fall in the year following for Lake Clark but not for Katmai. A slight decrease in park visitors is expected for large spills but not for small spills. Recreational fishing would drop slightly in areas affected by a spill (a year or two). A decline in spending by visitors would be in proportion to the decline in the number of visitors. Because the recreation and tourism facilities of the Kenai Peninsula already are crowded during the summer season, the additional population due to OCS activities will add somewhat to the congestion at recreational and tourism areas. Steps are being taken at Federal, State, and local levels to increase recreational opportunities; but the problem will continue to exist, and the proposal does add slightly to the problem. However, over the life of the proposal (30 years), the addition is minimal. At any time of the year, public water-oriented recreational facilities in parks, refuges, and recreational areas could be closed for a short time because of oil-spill-cleanup activities.

Conclusion: The cumulative effects of activities other than the proposed action would be additive to the base case and would amount to a total disturbance of 5 percent of all the resources. Oil-spill disturbance would amount to 1 to 3 percent of the resources for each particular area contacted by a spill. The resources would recover in a period of 3 years. A slight decrease in visitors to national and State parks and related recreational places is expected for large spills but not for small spills. Recreational fishing would drop slightly in areas affected by a spill (a year or two). A decline in spending by visitors would be in proportion to the decline in the number of visitors. The percentage of cumulative effects attributable to the proposed action is approximately 50 to 60 percent of all effects.

n. **Effects on Air Quality:** Air-quality regulations and procedures are discussed in Section IV.B.1.n, the base case. That discussion also describes the methodology used to model the air-quality effects associated with this proposed lease sale. The USEPA-approved OCD model was used to calculate the effects of pollutant emissions due to the proposal on onshore air quality. Because the Class I PSD areas allow for the least amount of degradation, the modeling scenario (i.e., source location) chosen for this analysis is the one that results in the maximum-potential effect to the air quality of the designated national wilderness area of the Tuxedni National Wildlife Refuge, the only Class I area adjacent to the proposed sale area. The maximum-potential effect at any location in the Class II area would be the same. In all likelihood, effects to the Tuxedni National Wilderness Area would be lower than those calculated by the model.

For purposes of this analysis, the cumulative case includes the activities as described for the base case. Other factors potentially affecting air quality would be existing and projected oil and gas operations onshore and the near offshore and transport vessels (LNG, oil, and coal) using shipping lanes through the lease-sale area. All other oil and gas operations are well beyond the area of potential cumulative effect from this proposal. Vessel traffic also would not contribute to the air-quality effects assessed for the base case (Sec. IV.B.1.n). Under these assumptions, peak-year emissions from exploration would be from drilling one to two exploration wells and two to three delineation well from one rig. Peak-year emissions from development would include platform and pipeline installation and the drilling of 20 production wells from two rigs. Peak-year production emissions would result from operations (producing 17 MMbbl of oil) and transportation. Table IV.B.1.n-1 lists estimated uncontrolled-pollutant emissions for the peak-exploration, peak-development, and peak-production years. The USEPA-approved OCD model was used to calculate the effects of pollutant emissions from the proposal on onshore air quality. Because the Class I PSD areas allow for the least amount of degradation, modeling for this proposal assumed maximum effect to the air quality of the designated national wilderness area of the Tuxedni National

Wildlife Refuge, the only Class I area adjacent to the proposed sale area. Under Federal and State of Alaska PSD regulations, a PSD review would be required due to the estimated annual uncontrolled NO_x emissions for the peak-development year would exceed 250 tons per year. The lessee would be required to control pollutant emissions through application of Best Available Control Technology (BACT) to emissions sources. Table IV.B.1.n-2 shows the modeled estimated with applicable regulatory limitations. The OCD model air-quality analysis performed for air pollutants emitted for exploration, development, and production under the base case showed that maximum NO_2 concentration, averaged over a year, would be 0.19, 0.51, and 0.14 $\mu g/m^3$, respectively, at the shoreline; 7.6, 20.4, and 5.6 percent, respectively, of the available Class I increment for NO_2; and .76, 2.04, and .56 percent, respectively, for Class II. (Other pollutants also were modeled; however, NO_2 had the highest concentrations, which were well within PSD increments and air-quality standards.) The existing air quality would be maintained by a large margin.

Other Effects on Air Quality For a more detailed discussion of the potential effects of air pollution—other than those effects addressed by standards—see Section IV.B.1.n.

Oil spills are another accidental source of gaseous emissions. Under the cumulative case, two 50,000-bbl spills are assumed. The estimated probability of one or more ≥1,000-bbl spills occurring is 64 percent. Smaller spills of <1,000 bbl would occur more frequently than larger spills. The number of small spills estimated for the cumulative case is 123, totaling 1,394 bbl over the life of the field (Table IV.A.2-4d).

The probability of one or more spills occurring is related to the oil-spill rate and amount of oil production. The VOC released by spills would be scattered spatially and temporally. Small spills could occur at a rate about the same as that for the base case.

Gas or oil blowouts may catch fire. In addition, in situ burning is a preferred technique for cleanup and disposal of spilled oil in oil-spill-contingency plans. For catastrophic oil blowouts, in situ burning may be the only effective technique for spill control.

The burning of spilled oil from the two spills assumed under the cumulative case would not differ appreciably from the base case. For any given fire, it is expected that any smoke reaching the shore would be dispersed, of short term, and limited to a local area, resulting in a minimal effect.

Effects at Nikiski, Alaska, and West Coast Ports: For a more detailed discussion, see Section IV.B.1.n(4). Assuming 30 tanker trips per year to west coast ports using 45,000 DWT tankers, tanker-loading operations in the peak-production year would result in an estimated 4 tons per year of SO_2, 3 tons per year of NO_x, 1 ton per year of PM-10, and 231 tons per year of VOC. Air-quality effects from SO_2 and NO_x would be insignificant. Effects from VOC emissions also would be insignificant because of the low potential for ozone formation in the area.

No increase in refinery throughput is expected since it is assumed that the Lease Sale 149 crude would displace North Slope oil that is currently received from the Valdez terminal. No change in refinery emissions is therefore expected.

Because of the relatively low number of tankers that would visit a particular port, the mitigating requirements that are in place, and because it is expected that Sale 149 crude oil would displace at least part of the oil coming from other sources, no effect on air quality would be expected at the West coast ports.

Conclusion: The effects associated with the cumulative case essentially would be the same, qualitatively, as those discussed for the Alternative I base case. Effects on onshore air quality from cumulative-case emissions are expected to be 20.4 percent of the maximum allowable PSD Class I increments. Only the Tuxedni National Wilderness Area is designated Class I, with the remaining area in and adjacent to the sale area designated Class II. Therefore, the potential effects would be much less. These effects would not make the concentrations of criteria pollutants in the onshore ambient air approach the air-quality standards. Consequently, a minimal effect on air quality with respect to standards is expected. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore from exploration, development and production activities, or accidental emissions would not be sufficient to harm vegetation. A light, short-term coating of soot over a localized area could result from oil fires.

o. **Effects on Coastal Zone Management:** The cumulative case considers the increased risk to resources and on subsistence as a result of oil produced from State leases, fishing, logging, and associated development and, in the case of coastal and marine birds, species introduced to the area. The Statewide standards and associated district policies covered in the base case remain relevant for the cumulative analysis. These include: coastal development; geophysical-hazard areas; recreation; energy facilities; transportation and utilities; fish and seafood processing; subsistence; habitats; air, land, and water quality; and historic, prehistoric, and archaeological resources. With the additional activities and the greater area included in the cumulative case, the Statewide standard and associated district policies related to Timber Harvest and Processing (6 AAC 80.100) and policies of the Kodiak Island Borough (KIB) also become relevant.

The introduction on timber harvests in the cumulative case introduces a number of new district policies. The Statewide standard requires that the Alaska Forest Resources and Practices Act and the regulations and procedures adopted under that chapter "constitute the components of the coastal management program with respect to those purposes" (6 AAC 80.100). The KIB CAMP further requires that "[t]imber harvesting activities shall be conducted in a manner that minimizes damage to, or loss of, anadromous fish streams and elk winter habitat and is consistent with State Forest Resources and Practices Act, the Forest Practices Regulations, and Title 16" (KIB CAMP Timber and Timber Processing 2). The KPB CAMP includes 7 criteria for forestry management to ensure adverse environmental effects and user conflicts are minimized, contains a preference for log storage above mean higher high water, and sets standards for in-water dumping and storage of logs that minimize adverse affects on the marine ecosystem and conflicts with recreational uses and activities (KPB CAMP 9.1 and 9.2). Forest activities carried out according to the district policies and existing regulations protecting eagles would help temper the adverse effects on terrestrial mammals and marine and coastal birds identified in Sections IV.B.12.d and g of this EIS.

Polices related to the Statewide standard for energy facility siting (6 AAC 80.070) require that facilities be consolidated. Application of this element would alleviate some of the effects noted for terrestrial mammals whose population losses related to some extent on loss of habitat and human-bear interactions at the various sites that are expected to be developed in the cumulative case.

The Statewide standard for subsistence (6 AAC 80.1200) and associated district policies might alleviate some of the potential effects on subsistence from the loss of habitat due to logging efforts as well as additional oil production from State leases. As in the base case, policies do not preclude development associated with this lease sale—or with other activities included in the cumulative case. The policies do require, however, that appropriate safeguards be instituted to protect habitat and resources used for subsistence purposes.

In the cumulative case, the greater extent of acreage involved increases the potential for activities to affect historic, prehistoric, or archaeological resources. Safeguards built into the ACMP, as well as State and Federal legislation, protect such sites if they are known and require that they be reported if they are discovered during the process of development. As a result, although there is a greater probability of encountering such sites under the cumulative case, the level of effects does not necessarily increase.

The KPB ACMP and KIB ACMP each contains a policy that specifically addresses cumulative effects. The KPB requires that "cumulative effects of proposed new and existing development on ambient air and water quality and coastal habitats shall be considered in the review or renewal of coastal projects" (KPB ACMP 2.7). The KIB ACMP requires, to the extent feasible and prudent, that ". . .[n]ew large-scale industrial developments to evaluate and provide information . . . of their potential cumulative impact on district air and water quality, prior to siting facilities. . ." (KIB ACMP Air and Water Quality 1). The cumulative analysis of effects on air quality indicates that even in the cumulative case, effects on air quality are well within the statutory limits. Water quality would exceed standards in the event of an oil spill, but all activities covered by an NPDES or State water-quality certificate would need to meet the mandatory requirements.

Summary: All policies that were included in the analysis of the base case remain important in the cumulative case. Those policies include: coastal development; geophysical-hazard areas; recreation; energy facilities; transportation and utilities; fish and seafood processing; subsistence; habitats; air, land, and water quality; and historic, prehistoric, and archaeological resources. Policies related to timber harvests, the KIB, and additional concerns of the KPB also are applicable in the cumulative case. The added policies emphasize consideration of cumulative effects in decisionmaking, especially cumulative effects associated with air and water quality.

Conclusion: Conflict with the habitat standard of the ACMP is possible. Site-specific information is necessary to ensure there is no conflict with the policies related to coastal development; geophysical hazards; energy-facility siting; transportation and utilities; subsistence; air, land, and water quality; and historic, prehistoric, and archaeological resources; conflict is not inherent in the scenario.

C. Unavoidable Adverse Effects on:

1. Water Quality: The activities associated with petroleum exploitation that are most likely to cause unavoidable adverse effects on water quality are (1) the permitted discharges from exploration-drilling units and production platforms, (2) oil spills, and (3) construction activities.

The permitted discharges would add substances that may be foreign to or increase the concentration of constituents already present in the water column of CI/SS. The added substances may cause sublethal to lethal effects in some marine organisms. The most significant discharges are (1) drilling muds (6,400-20,640 tons—dry weight) and cuttings (30,400 tons—dry weight) in concentrations estimated to range from 1,000 to 2,000 g/l from drilling 3 exploration, 5 delineation, and 48 production and service wells and (2) produced waters (18-148 MMbbl). The toxicity of the drilling muds generally is low and the concentrations of the bulk constituents becomes nontoxic at the dilutions reached shortly after discharge. When discharged, the toxicity of the produced waters is expected to range from slightly toxic to practically nontoxic and will decrease with continued mixing in the water column. The areas of potentially toxic waters are estimated to range in size from 0.03 to 1.77 km^2 (100-750-m radius, respectively). Mixing is expected to reduce the concentration of the discharges in these areas an estimated 1,000 to 1,000,000 times. Outside the mixing areas, the concentrations of the added substances are expected to be about the same as the background concentrations of the same or similar substances. The potential effects in any of the areas where there are permitted discharges would last for about 2 to 3 months for each exploration well drilled and about 21 years for development and production activities. Future procedures and technologies of treating and handling drilling muds and cuttings and produced waters may reduce or eliminate the amounts discharged.

The concentration of oil dispersed into the water column following an accidental spill is expected to affect areas 3 days after the spill that range in size from <10 km^2 for small spills ($<1,000$ bbl) to several hundred square kilometers for large spills ($\geq 1,000$ bbl). For small spills, the concentrations of dispersed oil are expected to be about the same as the background concentrations of total organic hydrocarbons (about 1.5 μg/l) within 30 days of the spill. For large spills, the concentrations of dispersed oil are expected to be exceed 15 μg/l (Alaska chronic criteria for the protection of marine life) in an area of several thousand square kilometers for 1 to <2 months.

Construction activities would increase the turbidity in the water column along segments of a 125-mi corridor for about 6 to 8 months.

2. Lower Trophic-Level Organisms: Unavoidable adverse effects on lower trophic-level organisms are expected due to drilling discharges, dredging and construction, and oil spills. Drilling discharges are expected to affect <1 percent of the benthic organisms in the sale area. Recovery of benthic organisms is expected to occur within 1 year. Less than 1 percent of the immobile benthic organisms in the sale area would be affected by platform and pipeline construction. Recovery is expected in <3 years. The assumed oil spill is expected to have lethal and sublethal effects on 1 to 5 percent of the plankton in the sale area. Recovery is expected to take 1 or 2 days for phytoplankton and up to 2 weeks for zooplankton. The assumed spill is expected to have lethal and sublethal effects on about 20 to 30 percent of the intertidal and shallow subtidal marine invertebrates in the sale area. Recovery of these communities is expected to take 2 to 3 years in high-energy habitats and up to 7 years in lower energy habitats. Less than 5 percent of the subtidal benthic populations in the sale area are expected to be affected. Small oil spills (estimated total of 555 bbl) may adversely affect individual lower trophic-level organisms in small areas immediately around the spills.

3. Fisheries Resources: Fish resources of the lower Cook Inlet region would be subjected to oil spills, but not at levels and frequencies where there would be effects on populations. Drilling discharges, offshore construction, and seismic surveys also would have small-scale adverse effects on fish resources. None of the foregoing are assessed as being of major significance to where they limit the numbers and distribution of regional finfish resources.

4. Marine and Coastal Birds: In this discussion, most oil-spill-related bird mortality is considered to be unavoidable (assuming a spill occurs), while most human disturbance of nesting seabirds, waterfowl, and shorebirds is considered to be avoidable through voluntary compliance with the recommendations on air and vessel traffic in the Information to Lessees on Bird and Marine Mammal Protection (see Sec. II.H).

The OSRA indicates that marine and coastal bird habitats such as Tuxedni Bay, the Alaska Peninsula, and the Barren Islands are at considerable risk of being contacted by the assumed 50,000-bbl spill. If the spill occurred during storm conditions, oil-spill-cleanup efforts are not expected to prevent the oil from contacting one or more of these habitats and resulting in the loss of several thousand seabirds and waterfowl. The unavoidable effect on marine and coastal birds is expected to be fairly long term (>1 to <3 generations).

Habitat alteration (increase in water turbidity near the activity sites) associated with the installation of off- shore platforms and offshore pipelaying is expected to be unavoidable but short term (≤1 season).

5. **Nonendangered Marine Mammals (Pinnipeds, Cetaceans, and the Sea Otter):** Some oil-spill effects are considered to be unavoidable during the life of the proposal. Effects due to noise and disturbance to marine mammals is considered avoidable through voluntary compliance with the recommendations on air and vessel traffic in the Stipulation on Protection of Biological Resources and ITL's No. 1, Bird and Marine Mammal Protection, and No. 2, Sensitive Areas to be Considered in Oil-Spill-Contingency Plans (see Sec. II.H).

The OSRA indicates that marine mammals in Tuxedni Bay and outer Kamishak Bay are at risk of being contacted by the assumed 50,000-bbl-oil spill. If cleanup were delayed or the spill occurred during storm conditions, spilled oil probably would contact one or more of these areas. This could result in mortality to sea otters, harbor seals, and other nonendangered marine mammals. The unavoidable effect on these species is that recovery is expected to take from 2 years to several generations.

Habitat alteration associated with the construction of offshore platforms and onshore facilities under the base case are expected to be unavoidable. Effects from this alteration should be short term and localized to the immediate vicinity of the facilities.

6. **Endangered and Threatened Species:** Most effects of noise and disturbance on endangered or threatened species are considered avoidable through voluntary compliance with the recommendations on air and vessel traffic in the Stipulation on Protection of Biological Resources and Information to Lessees on Bird and Mammal Protection and special considerations in the Information on Areas of Special Biological and Cultural Sensitivity and Information on Steller Sea Lion (see Sec. II.H.1, Mitigating Measures). Potential disturbance from platform construction and supply and seismic surveys, are considered unavoidable but, except supply traffic, are expected to be extremely localized, minor, and short term.

Some oil-spill effects are considered to be unavoidable during the life of the proposal. The oil-spill-risk analysis indicates that areas used intensively by endangered or threatened species, especially the Barren Islands and northern Shelikof Strait, are at risk of being contacted by the assumed hypothetical 50,000-bbl-oil spill. If cleanup were delayed or the spill occurred during storm conditions, spilled oil probably would contact one or more of these areas. This could result in some Steller sea lion pup mortality, but no mortality of endangered whales or birds is expected. Minor unavoidable disturbance effects experienced by these species is expected to last for the duration of the project. The Steller sea lion population is expected to recover any pup mortality within two generations.

7. **Terrestrial Mammals:** In this discussion, most oil-spill effects on terrestrial mammals are expected to be unavoidable (assuming an oil spill occurs), while human disturbance of coastal terrestrial mammals is considered to be avoidable through voluntary compliance with the recommendations on air and vessel traffic in the ITL on Bird and Mammal Protection (see Section II.H, Mitigating Measures).

The OSRA indicates that coastal habitats of brown bears and river otters, such as Tuxedni Bay, the Alaska Peninsula, and the lower Kenai Peninsula, are at considerable risk of being contacted by the assumed 50,000-bbl-oil spill. If the spill occurred during storm conditions, oil-spill-cleanup efforts are not expected to prevent the oil from contacting one or more of these habitats and resulting in the loss of some bears, river otters, and other terrestrial mammals. The unavoidable effect on brown bears and the local population of river otters is expected to persists for a number of years (no more than about 3 years) in coastal habitats that remain contaminated by the spill.

Habitat-alteration effects associated with the construction of onshore facilities under the development scenario are expected to be unavoidable, with the long-term displacement of a small number of brown bears and other terrestrial mammals (perhaps <10 bears) within <1 mile of the facilities.

8. **Economy:** Routine OCS activity is anticipated to generate increases of between a zero and 3 percent in resident employment, <3 percent in average income, <5 percent in cost of living, <2 percent in property tax, and <5 percent in sales tax on the western side of the Kenai Peninsula annually for <5 years. Property-tax revenue of $2.2 million for the KPB and $0.4 million for the State (in 1993 dollars) would be added annually after the year 2002.

The economic effect associated with accidental oil spills <1,000 bbl would have no effect on employment levels; therefore, the effect is not considered to be adverse.

A spill of as much as 50,000 bbl could generate considerable employment, which could be considered by local residents to be adverse, and inflation of housing rents, which probably would be considered adverse. These effects probably would be unavoidable if there were a large spill. A large spill would generate 5,000 cleanup jobs for 6 months in the first year, declining to zero by the fourth year following the spill. Local communities would experience a doubling in housing rents for 1 year.

9. **Commercial Fisheries:** Unavoidable adverse effects on the Cook Inlet commercial-fishing industry are expected due to offshore construction, seismic surveys, and oil spills. Offshore construction, platforms, and pipelines, are expected to result in some space-use conflicts (e.g., competition for docking space or gear loss); however, these are expected to be few in number and minor in scope. Seismic surveys, planned and coordinated with the commercial-fishing industry, are expected to have a minimal effect on the Cook Inlet commercial-fishing industry. Based on the assumptions discussed in the text, EVOS-loss estimates, and the average annual value of the Cook Inlet and Kodiak commercial fisheries, the assumed 50,000-bbl-oil spill is estimated to result in economic losses to the Cook Inlet commercial-fishing industry ranging from about 15 to 65 percent/year, for 2 years following the assumed spill. Losses to the Kodiak commercial-fishing industry from the same spill are estimated to range from about 5 to 25 percent year for 2 years following the spill.

10. **Subsistence-Harvest Patterns:** The direct loss or tainting of subsistence resources from an accidental oil-spill would unavoidably change subsistence-harvest patterns for the communities affected. Increased harvest pressure on subsistence resources from increased population also would be unavoidable, although such pressures would be subject to resource-management decisionmaking processes.

11. **Sociocultural Systems:** Increased population resulting from the lease sale could produce unavoidable adverse cross-cultural and cross-livelihood effects, especially for residents of the Kenai Peninsula. Changes in subsistence-harvest patterns as a result of oil spills or other operations would tend to further erode subsistence-based value systems, increase dependency on transfer payments to compensate for unmet subsistence needs, and increase levels of instability in subsistence-based systems of organization. Accidental oil spills and cleanup events that affect subsistence resources and disturb community well-being likewise would produce adverse effects that could be considered unavoidable.

12. **Archaeological and Cultural Resources:** In this discussion, most oil-spill effects are considered to be unavoidable, while most human disturbance, due to cleanup activities, looting, and accidental disturbance, is considered avoidable if compliance to mitigating measures and voluntary compliance with the ITL's (Sec. II.H) is practiced.

The OSRA indicates that archaeological and cultural areas onshore the Kenai Peninsula, Kodiak, and the Alaska Peninsula are at considerable risk of being contacted by the assumed 50,000-bbl oil spill. If the spill occurred during storm conditions, oil-spill-cleanup efforts are not expected to prevent the oil from contacting those segments listed in Section IV.A. The effects on archaeological and cultural resources, as seen during the EVOS, would be from cleanup efforts, looting, and accidental disturbance rather than direct oil-spill contamination (Reger, 1993; Bittner, 1993) and are thus avoidable.

13. **National and State Parks and Related Recreational Places:** In this discussion, most oil-spill effects are considered to be unavoidable, while most human disturbance, due to cleanup activities, destruction of facilities, and accidental disturbance such as fire damage, is considered avoidable if compliance with State and Federal laws and mitigating measures and ITL's (Sec. II.H) is practiced with regard to these resources.

The OSRA indicates that national and State parks and related recreational places onshore the Kenai Peninsula, Kodiak, and the Alaska Peninsula are at considerable risk of being contacted by the assumed 50,000-bbl oil spill. If the spill occurred during storm conditions, oil-spill-cleanup efforts are not expected to prevent the oil from contacting those segments listed in Section IV.A. The effects on such resources, as seen during the EVOS would be from cleanup efforts, destruction of facilities, and accidental disturbance such as fire damage rather than direct oil-spill contamination and are thus avoidable.

The unavoidable disturbance to national and State parks and related recreational places under the base case is estimated to be undetectable.

14. Air Quality: An increase in emissions of air pollutants would occur as a result of the proposed action. In all the alternatives and the cumulative case, the additional emissions would not be significant. In the event that any emissions are significant, they may be reduced by existing methods as necessary. For the proposed action, air-quality standards limitations would not be approached.

15. Coastal Zone Management: Effects on biological and cultural resources are considered unavoidable. These effects relate primarily to the consequences of an oil spill. Two of the three decisions related to facility siting are not subject to discretion in the scenario related to this lease sale. The terminal from which oil will be shipped to market already exists and the source of the oil will depend upon the location of the commercially viable oil deposits. Only the offshore pipeline connecting the two facilities will be subject to a siting decision. Strict enforcement of MMS's OSCP regulations, OPA 90 requirements, and early consultation with coastal districts and the State, as advised in the ITL on coastal management, should preclude conflict with Statewide standards and relevant district policies of the ACMP. Therefore, no avoidable adverse conflicts with the ACMP are anticipated.

D. **Relationship Between Local Short-Term Uses and Maintenance and Enhancement of Long-Term Productivity:** In this section, the short-term effects and uses of various components of the environment of the Cook Inlet Sale 149 area are related to long-term effects and the maintenance and enhancement of long-term productivity. The effects of the proposed action would vary in kind, intensity, and duration, beginning with preparation activities (seismic-data collection and exploration drilling) of oil development and ending with natural environmental balances being restored.

In general, short term refers to the useful lifetime of the proposal, but some even shorter term uses and effects are considered. Long term refers to the time beyond the lifetime of the proposed action. The overall life of the proposal under the base-case scenario is estimated to be 25 years, with 3 years of exploration and delineation activity and 22 years of oil development and production. Short term refers to the total duration of oil exploration and production, whereas long term refers to an indefinite period beyond the termination of oil production.

Many of the effects discussed in Section IV are considered to be short term (being greatest during the exploration, development, and early production phases) and are reduced by the mitigating measures (discussed in Sec. II.H), which are considered part of the proposal and the alternatives.

Minor construction projects, such as the installation of offshore platforms and the laying of the 125-mi long 12-in pipeline and the tank farm, would cause definite changes in the short term (over the life of the proposal), with some localized short-term effects onshore at the tank-farm site (a few acres at Nikishka). In the short-term, biological productivity would be reduced or lost on the onshore lands tanker site.

In offshore areas, construction projects could cause short-term changes by altering the local habitats of some marine-benthic organisms. Short-term oil pollution and the possibility of long-term accumulations of pollutants could cause adverse effects on some components of the marine ecosystem. Even though these events are unlikely, the potential must be recognized. A short-term (1 to <2 months), offshore regional decrease in water quality could be considered to be a necessary tradeoff for obtaining hydrocarbon resources. The biota would be threatened in the short term by potential oil pollution.

Disturbances associated with increased volume and frequency of noise from vessel traffic or overflying aircraft could alter behavior patterns and temporarily drive fauna from some feeding and breeding grounds or to other habitat areas within their ranges, thus reducing the local populations of species over a short period of time.

Habitat modification or destruction could cause a very limited local reduction in subsistence, commercial, and sport resources. The improved accessibility to primitive areas from increased construction would be both a short-term and long-term result of the proposal. The wilderness values of the coast and in the areas along the pipeline routes would decrease with increased human activity in these areas. Land use changes would be evident at the shore-base site and along the pipeline routes. Short-term changes include a shift in land use from subsistence- and sport-based activities to industrial activities throughout the life of the proposal. Zoning for the onshore tank-farm area would change. This would be a short-term change if, after production ceases, use of the land reverts to previous uses. Long-term effects on land use could result if use of the infrastructure or facilities continues after the lifetime of this proposal. Potential users would be other resource developers, residents, or nonresidents who have become accustomed to the convenience of using existing facilities.

Increased population, minor gains in revenues, and the consequences of oil spills all contain the potential for disrupting Native communities in the short term. The 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 lease sale would 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, such finds could help locate other sites, but any destruction of artifacts would represent long-term losses.

Consumption of offshore oil would be a long-term use of nonrenewable resources. Economic, political, and social benefits would accrue from the availability of oil. Most benefits would be short term and would decrease the Nation's dependency on oil imports. If additional supplies were discovered and developed, the assumed production system would enhance extraction.

The production of oil from the Cook Inlet Sale 149 area would provide short-term energy and perhaps time for the development of long-term alternative-energy sources or substitutes for petroleum. Regional planning would aid in controlling changing economics and populations and, thus, in moderating any adverse effects.

Alternatives to the proposed action—such as cancellation, delay, and the deferral alternatives—would reduce to varying degrees both the long- and short-term environmental effects as well as the long- and short-term energy benefits. The overall long-term effect of Sale 149 would be a small reduction in the productivity of the environment.

E. Irreversible and Irretrievable Commitment of Resources: The undiscovered, economically recoverable resources assumed to be leased in the base case amount to 200 MMbbl of oil. Should these resources be discovered, they would be irretrievably consumed.

1. Effects on Lower Trophic-Level Organisms: Lower trophic-level organisms would be exposed to drilling discharges, dredging and construction, and oil spills associated with this proposal. While a relatively small percentage of these organisms are likely to be affected by these agents, they are not expected to experience any irreversible and irretrievable effects associated with this proposal.

2. Effects on Fisheries Resources: Offshore oil and gas development in the lower Cook Inlet region would alter limited areas of benthic habitat for the foreseeable future, which probably would displace some finfish species while proving attractive to others, e.g., offshore structures increase substrate for organisms that are prey and predator. The distribution of finfishes would not be affected on a large scale. Increased oil and gas development has and would result in increases in the regional human population with concurrent pressure on the populations of some finfish resources, particularly salmonids.

3. Effects on Biological Resources (Birds, Marine and Terrestrial Mammals, and Endangered and Threatened Species): General development activities, such as increases in human populations and other related land-based activities that increase human access to bird and mammal terrestrial and marine habitats, could displace some nesting marine and coastal birds, terrestrial and marine mammals (such as brown bears and seals), and endangered and threatened species (e.g., Steller sea lion) from important habitats to less-favorable environments. This displacement eventually could result in reduced population levels or result in changes in distribution. This displacement could become irretrievable if the environment and habitats were permanently altered by human activities.

4. Effects on the Economy: The commitment of economic resources, namely human resources, would be irreversible and irretrievable. That is, the routine activity would generate between a zero- and 3-percent increase in resident employment in the region annually for up to 5 years. Activity associated with accidental oil spills ≤1,000 bbl would have no effect on employment levels. A large oil spill would generate 5,000 cleanup jobs for 6 months in the first year, declining to zero by the fourth year following the spill.

5. Effects on Commercial Fisheries: Based on the assumptions discussed in the text, EVOS-loss estimates, and the average annual value of the Cook Inlet commercial fishery, the assumed 50,000-bbl-oil spill is estimated to result in economic losses to the Cook Inlet commercial-fishing industry ranging from 15 to 65 percent per year. Losses to the Kodiak commercial-fishing industry from the same spill are estimated to range from about 5 to 25 percent year for 2 years following the spill. However, based on the EVOS experience, these losses are likely to occur for only 1 or 2 years over the 30-year life of the proposal, and are likely to be fully compensated for (several times over) by the oil industry. Hence, the Cook Inlet and Kodiak commercial-fishing industries are not expected to experience any irreversible and irretrievable economic effects associated with this proposal.

6. Effects on Subsistence-Harvest Patterns: Subsistence-harvest patterns would be irreversibly affected in one or more communities on the southern Kenai Peninsula by the displacement of subsistence resources from customary and locally used habitat or by the reduction of resources through the modification of favorable habitat. The replacement could be irretrievable if the effects were maintained over time.

7. Effects on Sociocultural Systems: Irreversible changes in cultural values and orientations would occur from the introduction of added resident population, effects on subsistence-harvest patterns, and effects from oil spills and cleanup events; but the irretrievable nature of these changes to sociocultural systems is unknown.

8. Effects on Archaeological and Cultural Resources: Important data from archaeological sites could be lost through looting and indiscriminate or accidental activity on known and unknown sites. Interpretation of the data in situ is a very important factor in dating and interpreting sites. The orientation program and the archaeological resource stipulations would protect against such losses. Based on the large *Exxon Valdez* oil spill, in which about 1 percent of the resources was lost, it is estimated that <1 percent of the archaeological resources in the Sale 149 area would be affected.

9. Effects on National and State Parks and Related Recreational Places: The cultural part of our recreational system involves both symbolic and material cultural products. The *Exxon Valdez* oil spill destroyed and disturbed between 1 and 3 percent of the shoreline biomass (Sec. IV.B.1.a-g) and changed the water quality during that time period. A small percent of resources that related to recreational sport and viewing cannot be completely recovered and, therefore, the use and viewing of them cannot occur. For tourists who canceled trips—tour boating, kyaking, sportfishing, shoreline camping—in the spill area, the experience was irretrievable. Local residents who depend on the tourist trade lost resources that can never be retrieved. Based on the amount of shoreline national parks, wildlife refuges, and recreational areas affected by the base case (an estimated 1,000 such shoreline sites), about 2 percent would be disturbed and about 2 percent of those would not be retrievable to the original state. The image of Alaska as a tourism area of beautiful national parks, wildlife refuges, and recreational areas would not be immediately retrieved. In summary, it is estimated that <2 percent of all the national parks, wildlife refuges, and recreational areas in the proposed Sale 149 area would be irreversibly and irretrievably committed.

F. Effects of Natural Gas Development and Production: Natural gas may be discovered in the Sale 149 area during exploration drilling. Although gas resources are not considered economic to exploit at this time or in the foreseeable future (see Appendix A), they could be developed and produced at some undetermined future time. Under such circumstances, natural gas production probably would not occur until after oil production had begun. Thus, leases containing nonassociated natural gas that could be recoverable in the future probably would be retained by the leaseholder. (Associated and dissolved gases that are recovered along with the crude oil are expected to be reinjected or used as fuel, depending on the amount recovered.) The effects of potential gas development and production on the environment of the Sale 149 and adjacent areas that would be additional to the effects associated with oil development and production are described in this section.

Additional facilities and infrastructure would be needed if and when the nonassociated natural gas is developed and produced. The gas could be produced through wells drilled from gas-production platforms.

A large-diameter pipeline would be installed to transport the produced gas from the production platform(s) to an onshore gas-processing facility probably located in Nikiski; the gas pipeline would be separated from any existing oil pipelines to the extent necessary to minimize the risks that would arise during installation and operation. No offshore booster-pump stations would be required between the platforms and the gas facility.

Natural gas would be piped to a landfall at or near the Nikiski petroleum complex and then piped to a liquefied natural gas (LNG) facility located at Nikiski. At Nikiski, the gas would be liquefied and shipped to market. At the present time, the most likely market would be Asia, as Cook Inlet LNG currently is shipped to Tokyo, Japan. However, should a regasification plant be constructed on the U.S. west coast, a market also could develop there.

Effects of natural gas development and production on the biological resources, social systems, and physical regimes of the Sale 149 and adjacent areas could be caused by gas blowouts; installing offshore pipelines and gas-production systems; drilling gas-production wells; installing onshore pipelines and a gas-processing facility; marine-, surface-, and air-traffic noise and disturbance; construction activities; and growth in the local economy, population, and employment.

Accidental emissions of natural gas could result from a gas-well blowout or a pipeline rupture. In the unlikely case that such an event occurred, a gas-well blowout probably would not persist for > 1 day and would release perhaps 20 metric tons of gaseous hydrocarbons; 60 percent of all blowouts since 1974 have lasted ≤ 1 day. From such a blowout, a hazardous plume of gas could extend downwind for about a kilometer but quickly would dissipate once the blowout ceased. The amount of VOC released by such a blowout would be less than that evaporated from an oil spill ≥ 1,000 bbl.

The rupture of a gas pipeline would result in a short-term release of gas. A sudden decrease in gas pressure automatically would initiate procedures to close those valves that would isolate the ruptured section of the pipeline and thus prevent a further escape of gas.

1. Effects on Water Quality: Natural gas development and production would cause some temporary, localized, degradation of water quality as a result of the (1) routine, permitted discharge of drilling muds and cuttings, produced waters, and other discharges; (2) the siting of the platform; and (3) the construction of a pipeline.

Gas-production-well drilling would cause the discharge of drilling muds and cuttings. The discharge of produced waters also would be associated with natural gas production and is an issue of concern because of the types and amounts of naturally occurring substances they may carry and the manmade substances that may be added. However, as noted in Sections IV.B.1.a(1)(a)2 and IV.B.1.a (2), the discharge of muds and cuttings, produced waters, and other discharges are not expected to have any effect on the overall quality of Cook Inlet water.

The amount of disturbance associated with gas-platform siting would be minimal and restricted to the area immediately around the activity. Sediment levels likely would be reduced to background levels within several hundred meters downcurrent. Resuspension and seafloor disturbance associated with offshore-pipeline construction would occur along the entire pipeline route. The effects of pipeline laying would be local and would occur only during periods of construction; construction activities are not expected to affect the overall quality of Cook Inlet water.

Conclusion: The quality of Cook Inlet water would not be affected by natural gas production and would remain good (unpolluted).

2. **Effects on Lower Trophic-Level Organisms:** If a natural gas blowout occurred, marine plants and invertebrates in the immediate vicinity might be killed. Natural gas and condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations. A plume of natural gas vapors and condensates would be dispersed very rapidly from the blowout site, but it is not expected to be hazardous for > 1 km downwind or for > 1 day.

Activities associated with laying a gas pipeline would have localized effects on marine organisms. For mobile lower trophic-level organisms such as adult crabs, virtually no adverse effects are expected; however, longer term but extremely localized effects over a small area are possible for immobile benthic organisms such as clams. In some instances, the alteration of the benthos by pipeline laying could enhance habitat for some lower trophic-level organisms.

Conclusion: Natural gas exploration and/or development in lower Cook Inlet are expected to have little to no effect on lower trophic-level organisms.

3. **Effects on Fisheries Resources:** If a natural gas blowout occurred, marine fishes, eggs, and larvae near the blowout point probably would be killed. Natural gas condensates in the water column would be hazardous to any fish, eggs, or larvae that were exposed to high concentrations. However, a plume of natural gas vapors and condensates would disperse rapidly from the blowout site and is not expected to be hazardous to fisheries resources.

Activities associated with laying a gas pipeline would have localized effects on marine fishes, mainly benthic species. Marine fishes could be displaced by the physical alteration of their habitat by actual pipelaying and the associated turbidity. This would be limited to the construction period and shortly thereafter (on the order of days to weeks). In some instances, the alteration of the benthos by pipeline laying could enhance habitat for some demersal fishes.

Conclusion: Natural gas exploration and/or development in lower Cook Inlet probably would have no adverse effects on pelagic, semidemersal, or demersal fish populations. Some benthic fishes may be displaced temporarily from certain locales due to pipelaying activities, but this displacement is not expected to exceed several weeks' duration.

4. **Effects on Marine and Coastal Birds:** The most likely effects associated with natural gas development and production on marine and coastal birds include noise and disturbance associated with air and vessel traffic (perhaps 30-60 air and vessel trips) to and from gas-exploration and production platforms in the sale area. These effects are expected to be similar to the effects described under the base-case analysis of oil exploration and development. Air- and vessel-traffic noise and disturbance effects are expected to include short-term displacement of birds (a few minutes to a few hours) with no long-term effects expected.

If a natural gas blowout occurred with an explosion and fire, birds in the immediate vicinity would be killed. Blowouts of natural gas condensates that did not burn would be dispersed very rapidly at the blowout site; thus, it is not likely that toxic fumes would affect birds or their food sources except those very near the source of the blowout. Bird mortality associated with the blowout could involve several hundred to thousands of birds, but this loss is expected to involve several different species of marine and coastal birds with no one population suffering losses that would not be replaced within about 1 year.

Conclusion: The overall effect of natural gas development on marine and coastal birds is expected to include short-term displacement (a few minutes to a few hours) from air and vessel traffic. A natural gas blowout, although an unlikely event, could result in the loss of several hundred to thousands of birds; but this loss is expected to involve several different species with no one population suffering a loss that would not be replaced within about 1 year.

5. **Effects on Nonendangered Marine Mammals (Pinnipeds, Cetaceans, and the Sea Otter):** The principal effects of natural gas development and production on pinnipeds, cetaceans, and the sea otter would

result from air traffic to and from the production platforms and from activities associated with the construction of platforms, offshore pipelines, and an onshore gas-processing facility. Pinniped response to low-altitude aircraft could result in stampede or flight into the water. This could increase pup mortality during the pupping season. Both baleen and toothed whales usually respond to low overflights by diving. Disturbance reactions by marine mammals usually are short term, with seals reoccupying haulouts and whales continuing their activities usually within a matter of hours.

The effect of installing gas-producing platforms and laying gas pipelines would be similar to the effect of installing oil-production platforms and laying oil pipelines. Such activities could cause pinnipeds and cetaceans to forage in less-suitable habitat or areas with lower prey availability. This disturbance likely would be relatively short term and very localized (on the order of hours to days, within about 1 km^2).

If a natural gas blowout occurred with possible explosion and fire, marine mammals in the immediate vicinity of the blowout could be killed. Natural gas and gas condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations. Toxic fumes associated with the blowout are expected to disperse quickly and have a minimal effect on marine mammals. It is not likely that these pollutants would affect any marine mammals except individuals present in the immediate vicinity of the blowout. Particularly vulnerable to such an explosion would be surface-dwelling marine mammals such as sea otters or rafting fur seals. Marine mammal mortality associated with the blowout is expected to involve up to 100 sea otters or fur seals, but the loss is not expected to exceed natural mortality. Recovery to pre-blowout population levels are expected to occur within a year.

Conclusion: Effects of natural gas exploration and development to marine mammals would be minimal and limited to short-term (hours to days) displacement or disturbance reaction to vessel and aircraft traffic and construction activities. A natural gas explosion is estimated to affect surface-dwelling marine mammals—sea otters and rafting fur seals. Mortality associated with the blowout is expected to involve up to 100 sea otters or fur seals, but the loss is not expected to exceed natural mortality. Recovery to preblowout population levels are expected to occur within 1 to 2 years.

6. **Effects on Endangered and Threatened Species:** If natural gas exploration and development occur, effects are expected to be similar to those described under the base case for oil exploration and development. Potentially disturbing activities originating from a drill rig, supply vessels and aircraft, construction and pipeline-laying activities, or a gas-production platform are expected to cause small numbers of endangered whales and Steller sea lions to temporarily avoid the areas within a few kilometers of where such activities occur and/or exhibit negative behavioral responses. Laying a gas pipeline would disturb only a small amount of potential gray whale benthic foraging habitat, and gray whales are not known to feed extensively during their migration through this area. The effects of disturbance associated with natural gas development on populations of these species are expected to be minimal; no effects on populations of listed bird species are expected because of their rarity in the proposed sale area.

If a natural gas blowout occurred—with possible explosion and fire—it is possible that endangered whales or sea lions in the immediate vicinity could be injured or killed, particularly if the release occurred at or below the water surface. However, because both whales and sea lions typically are widely dispersed as individuals or small groups in the pelagic environment and would be expected to be moving through the area either migrating or on foraging trips (and are likely to avoid a platform site or gas release, as discussed above), few would be exposed to a point-source leak from either a platform or a pipeline. Natural gas and condensates that did not burn in the blowout would be dispersed very rapidly once the blowout ceased (estimated to be ≤1 day), and it is not likely that they would affect dispersed endangered whale or sea lion populations.

Conclusion: Overall effects of natural gas development on populations of endangered whales and the Steller sea lion are expected to be minimal.

7. **Effects on Terrestrial Mammals:** The most likely effects of natural gas development and production on terrestrial mammals are expected to come from noise and disturbance associated with air traffic (perhaps 30-60 trips/month) to and from offshore gas platforms and the onshore support base. Noise and disturbance from air and road traffic is expected to cause short-term (a few minutes to a few hours) displacement of brown bears, moose, and other terrestrial mammals within < 1 mi of the traffic.

If a natural gas explosion and fire occurred on or very near the coast, a number of river otters (perhaps ≥10) and other terrestrial mammals could be killed or displaced, particularly if some coastal forest were burned as a result of the accident. However, losses to any one terrestrial mammal population are not expected to exceed natural mortality or, if they do, the losses are expected to be replaced within 1 to a few years.

Conclusion: The overall effect of natural gas development on terrestrial mammals is expected to involve short-term displacement (a few minutes to a few hours) from air and road traffic associated with gas exploration and development. A natural gas accident on or near shore involving explosion and fire could result in the loss or displacement of a number of river otters (perhaps ≥10) and other terrestrial mammals, if some coastal forest is burned as a result. However, these losses are not expected to exceed natural mortality or, if they do, the losses are expected to be replaced within 1 to a few years.

8. Effects on the Economy: Activity associated with this natural gas development and production scenario would generate effects at the same level as the base-case activities.

Conclusion: Routine OCS activity for the natural gas development and production would generate a change between zero and 3 percent in resident employment, <3 percent in average income, <5 percent in cost of living, <2 percent in property tax, and <5 percent in sales taxes on the western side of the Kenai Peninsula each year for <5 years. Property-tax revenue of $2.2 million for the KPB and $0.4 million for the State (in 1993 dollars) would be added annually after the year 2002.

9. Effects on Commercial Fisheries: The exploration and development of natural gas resources in Cook Inlet require the drilling of exploration wells, placement of one or more production platforms, and laying pipeline to transport the produced natural gas onshore. These activities could interfere with commercial fishing, particularly where fixed gear is in use. This gear could be damaged or lost by vessel traffic with subsequent economic loss to the affected commercial fishermen. However, space-use conflicts of this type are likely to be infrequent, minor in scope, and reimbursed by the oil industry. Offshore construction, gas platforms, drilling discharges, and pipelines are expected to displace commercial fishing from small areas near the activities but would have no measurable effect on commercial fishing.

Conclusion: Exploration and development of natural gas resources in Cook Inlet are expected to result in a small number of space-use conflicts with no measurable effect on commercial fisheries overall.

10. Effects on Subsistence-Harvest Patterns: Effects on subsistence-harvest patterns from natural gas development and production could occur from natural gas blowouts, noise, and traffic disturbance and construction activities. These effects of natural gas development and production on the biological resources harvested for subsistence use are discussed above. If a natural gas blowout occurred, the subsistence harvest of any species in the vicinity could be affected. Additionally, if a natural gas blowout occurred—with possible explosion and fire—subsistence resources in the immediate vicinity probably would be killed. Natural gas and condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations. However, natural gas vapors and condensates would be dispersed very rapidly from the blowout site (1 km downwind for about 1 day) and would affect only those species in the immediate vicinity of the accident. While such an effect would be short term and localized and would not be likely to measurably affect the regional population of any species, it could cause disruption to subsistence harvests in the area of the blowout. However, this disruption would be short term and would not cause any species to become locally unavailable for more than one season.

The effects of installing and constructing gas-production platforms, laying gas pipelines, and activities associated with constructing onshore pipelines to connect the offshore-production platforms with the onshore-processing facility would be similar to the effects of installing and constructing oil-production platforms and pipelines. As with construction activities associated with oil development and gas production, effects are likely to be short term, occurring only during the period of construction (which could disrupt subsistence harvests for the entire season in the vicinity where those activities would occur).

Air and boat traffic—as well as road traffic along the pipeline route—associated with natural gas development and production would be additional sources of disturbance to subsistence harvests. However, the estimated level of noise and traffic disturbance is not expected to be greater for natural gas development and production than the level estimated for oil development and production.

Conclusion: Effects of natural gas development and production on subsistence-harvest patterns may include the expiration of resources in the immediate vicinity of a blowout and possible explosion and fire and the disruption of subsistence harvests at the site and during the time of processing-facility and pipeline construction.

11. **Effects on Sociocultural Systems:** Effects on sociocultural systems would be due to changes in employment and population and from effects on subsistence-harvest patterns. In the event of natural gas development and production in the Sale 149 area, there would be a slight increase in employment and population in the region adjacent to the Sale 149 area. However, these increases in employment and population are expected to amount to an insignificant number and would not have any measurable effect on the sociocultural systems above that estimated to result from oil development and production. Effects levels of gas development and production on subsistence-harvest patterns in and adjacent to the Sale 149 area are not expected to exceed those already occurring from oil development and production; thus, there would not be an increased level of effect on sociocultural systems because of disruptions in subsistence harvests.

Conclusion: Effects of natural gas development and production on sociocultural systems from increases in population and/or employment and effects on subsistence-harvest patterns are not expected to exceed those associated with oil development and production.

12. **Effects on Archaeological and Cultural Resources:** Offshore archaeological resources could be affected by activities associated with potential installation of gas-production platform and pipeline. Such activities would require an archaeological survey if they are proposed for areas having potential for the occurrence of archaeological resources. Onshore archaeological resources would be affected by activities associated with gas-producing facilities and pipeline installations; disturbance of onshore archaeological resources could occur at the time of construction activity. Disturbance also might occur as a result of onshore activity associated with accidents such as a gas blowout or explosion. Cleanup after such accidents could result in disturbance by graders or bulldozers being transported overground to the accident site. Such surface disturbance is likely to affect existing archaeological sites.

Conclusion: The expected effects would be damage to archaeological resources in the immediate vicinity of the blowout. This damage would be permanent.

13. **Effects on National and State Parks and Related Recreational Places:** Offshore national and state parks and related recreational areas could be affected by activities associated with potential installation of gas-production platforms and pipelines. Such activities would require consultation with the National Park Service and a survey of the affected areas to determine effects to these resources. Onshore resources would be affected by activities associated with gas-processing facilities and pipeline installations; disturbance of onshore resources could occur at the time of construction activity. Disturbance also could occur as a result of onshore activity associated with accidents such as a gas blowout, spilled liquid gas, or a gas explosion. Cleanup after such accidents could result in disturbance by graders or bulldozers being transported overground to the site. Such disturbance likely would damage only some resources because of planning prior to the onshore activities being initiated.

Conclusion: The expected effects of natural gas activities on national park, wildlife refuge, and recreational area resources would be damage to <[illegible] percent of these resources for a period of approximately 2 years.

14. **Effects on Air Quality:** The primary air pollutant would be VOC, more than 90 percent of which can be controlled by existing technology. The emissions from gas-production platforms and storage and treatment facilities would be analogous to those discussed in Section IV.J.6 of the Norton Sound Sale 100 FEIS (USDOI, MMS, Alaska OCS Region, 1985). The emissions from any gas blowouts (principally VOC) would quickly evaporate, be burned, or be dissipated by winds with minimal effect on air quality (USDOI, MMS, Alaska OCS Region, 1985).

Development drilling and platform and pipeline installation associated with natural gas resources would result in additional emissions of CO, SO_2, NO_X, and VOC. These emissions would be produced from the same sources producing emissions in oil-development and -production activities. On an energy-equivalent basis, production and offshore processing of natural gas emits fivefold fewer air pollutants than does oil production and processing.

Effects of Accidental Emissions: Accidental emissions result from gas blowouts. The number of OCS blowouts—almost entirely gas and/or water—averaged 3.3 per 1,000 wells drilled since 1956 (Fleury, 1983). The data show no statistical trend or a decreasing rate of occurrence. The blowout rate has actually averaged somewhat higher since 1974, at 4.3 per 1,000 wells drilled; but the difference between the post-1974 period and the longer 1956 to 1982 record is statistically insignificant.

Conclusion: A minimal effect on air quality with respect to standards is expected. Principally because of the distance of emissions from land, the other effects of air-pollutant concentrations at the shore due to exploration, development and production activities, or accidental emissions would not be sufficient to harm vegetation.

15. Effects on Coastal Zone Management: Natural gas development and production may occur on leases in the same area and follow the same transportation routes as oil production resulting from Sale 149. No further change in land use is anticipated as an LNG facility already exists on the Kenai Peninsula. Many effects from the base case that created potential conflict with the Statewide standard for habitats related to effects from oil spilled during transportation. Such oil spills are not associated with the transportation of LNG; therefore, the potential for conflicts with the habitat and subsistence policies is less likely for gas production than it is for oil production.

Conclusion: Nothing in the scenario inherently conflicts with the major siting elements of the Alaska Coastal Management Program and the district policies of the Kenai Peninsula Borough's CMP.

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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 **Royalty Management Program** meets its responsibilities by ensuring efficient, timely and accurate collection and disbursement of revenue from [illegible] production due to Indian tribes and allottees, States and the U.S

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.